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THE

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1898

Edition

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A STRIKE LESSON.

THE latest issue of the *Amalgamated Engineers' Monthly Journal* contains an article dealing with co-operation, which our contemporary considers to be worth more than passing notice. So far as we ourselves can learn, co-operation has not been a huge success in its principal home—Lancashire. We are at least aware that there is a good deal of surprise expressed by people generally as to the very considerable amassment of property by many managers of "co-op." stores, whose salaries could never account for a tithe thereof.

The article in question recognises the need of capital in any industry. No industry can be carried on without capital, nor is capital of the slightest use unless present in sufficient quantity, and backed by a sufficiency of patience to await fructification. The A.S.E. writer speaks of capital being banded together to do battle for privilege and monopoly, to control even Government, and boycott the small employer into subjection. *Engineering* thinks the words privilege and monopoly have got a bit twisted. The fight was rather over the question of the Union's privilege of ordering how employers should conduct their works. Any monopoly claimed was claimed by the A.S.E. for its own members' exclusive right to certain work, while boycott may be left to the reader's imagination.

The article urges men to become their own employers, to devote their surplus capital to co-operation—it is something that any surplus is admitted. Unlike *Engineering*, however, we do not quarrel with the quality of free spending of the working man, though we may quarrel with some of the directions of his expenditure. If a man saves and invests his savings, he helps on industry and reaps the benefit both directly and indirectly. If the workman does not save he must be helping trade very directly, but the huge prosperity of the big brewers seems to negative the idea that, as a rule, the free spender is helping himself very much, as there is very little labour in brewing. Few towns so small as Burton turn out so large a nominal value of product. *Engineering* recommends saving in beer and "baccy," in order to secure at once capital to start a works big enough to employ a fair proportion of the men in a given factory who should elect to go on the saving plan. Efficiently managed, and with profits ploughed in, men might soon all become their own employers. But jealousy and mistrust are great enemies to co-operation. Efficient management would demand a better wage than the ordinary workman, and the manager's post in a co-operative factory, owned by the men who would have to obey the, perhaps, servant manager, would not be a happy one. John Burns's saying that no man was worth over £500 a year was, says our contemporary, a very foolish saying.

We, ourselves, remember a case in Manchester where a man was discharged because his employers could not admit the propriety of "any servant of ours earning £3,000 a year." They discharged him, and the business simply died out. The *A.S.E. Journal* cites an instance of a co-operative engineer-

ing works at Leicester which is a success, but there is somewhat of a suspicion, however, that it is nursed.

There is also a South London Engineering Society engaged chiefly on bicycles, but it requires both shareholders and customers. We venture to say that if working men want to save and own works, there is no better way at the present time than that open by way of the Limited Liability Act. A limited company with a good board and an able manager, and articles of association forbidding any shareholder worker interfering, save in the meetings, might do some good. Railway shareholders are all part of a co-operative concern, and many railway servants, perhaps, own more shares than their superior officers; but this avails them nothing if they neglect their duties.

There are, however, various ways in which a working man may save without risk, and provide for a rainy day. He may keep up his trade union as a benefit society, and also have a share in the so-called war chest. The war chest ought to be used, however, for peace in place of being an incentive to fight, as the late fund of £350,000 so unfortunately proved to be.

Undoubtedly capital is apt to be greedy, and never more so than when it can use labour of either hand or brain to the best advantage, and to secure big returns. It should be the aim of both the hand and the brain worker to do the best possible for himself and for capital, while at the same time being able to refuse to be squeezed. The wilful waste of the A.S.E. fund was made when capital was not trying to squeeze labour, hence the folly of the strike. Why was not the £350,000 put into a modern factory to make, say, direct acting steam pumps on an eight hours' day, with none but members of the A.S.E. to do every piece of work, with none but A.Es. on machine work—with no half pay boys or youths, and with all the modern tools run at the same slow speeds allowed to employers? It is a bit foolish this call for co-operation from men who profess it proper to disallow a man to work more than one tool. We fear the writer in the *A.S.E. Journal* has little economic knowledge.

It is not a little strange to see how the working man can be persuaded out of large strike levies for months at a time. Say there are 80,000 members of the A.S.E. Then 4s. a week from each is £16,000, or nearly a million annually. Strike levies recently were as high as 6s. weekly. Every week a nice little business could be taken over. But this they will not do.

Is the Nervous System a Coherer?

In a note presented to the *Academie des Sciences* on December 27th last, M. Branly pointed out some striking analogies between the conductivity of discontinuous conductors, and the conductivity of the nerves for nervous currents. That physiologists have already recognised a general analogy between a nerve and an electric conductor, is proved by their use of the term "nervous current." Up till recently, however, they appear to have looked upon the nerve as a continuous conductor. But, in recent years, histological researches have shown that the nervous system is composed of discontinuous elements—*neurones*—without any cementing substance between them, and connected together by the contiguity of their ramified extremities only. It follows, that the nervous wave propagates itself by contiguity, and that it is arrested by any defect in the contiguity. If it is no longer possible to maintain that there is any analogy between the nerves and continuous conductors, it will be evident that a very striking analogy exists between the nervous system and a system of discontinuous conductors. Several results, deduced from a comparison of the working of discontinuous conductors, and the physiological action of the nerves, appear to point to some analogy between them. In the same way that a shock reduces or annihilates the conductivity of discontinuous conductors, *traumatism* produces anesthesia and hysterical paralysis, due to a suppression of nervous transmission either in the sensory or motor nerves arising from imperfect contiguity of the nerve terminals. On the other hand, electric discharges act most efficaciously as a cure for hysterical paralysis and anesthesia, just as electric oscillations augment the conductivity of discontinuous conductors. This points to the hypothesis that the effect is determined in both cases by the contiguity, or something equivalent to the contiguity, of the elements. The parallelism between the effects of shock and of sparks upon coherers and upon the hysterical nervous system may be recognised in the susceptibility to reaction under a feeble action which remains after a powerful initial shock. This M. Branly has shown to be true of coherers in his note to the Academy of December 6th, and it is well known to be a property of the nervous system. High frequency discharges, and the electrical oscillations which accompany them, are well adapted to render discontinuous conductors continuous; and these discharges have been shown by MM. d'Arsonval and Apostoli to exercise a decided therapeutic effect upon the affections due to defects in nutrition. If these affections are of a nervous order, and are capable of being attributed to an imperfect transmission of the nervous current, it is permissible to assume that electric oscillations act so as to re-establish between the nerve elements a contiguity which was becoming insufficient. Branly has shown, on a former occasion, that continuous currents of sufficient E.M.F. produce by their transmission through coherers the same effects as electric discharges at a distance. This action of continuous currents is subject to the same general laws as the action of electric discharges; persistence, disappearance with shock and heat, sensibility to less E.M.F. produced by the previous action of a battery of high E.M.F. Continuous currents also act upon the nervous system, and it will be an interesting subject for research to determine whether their action is analogous to that on coherers. M. Branly does not maintain that coherer and nervous actions are the same in every respect, but he considers that the similarity is sufficient to form a valuable guide to the electrotherapeutist in his future researches.

High Speeds on Electric Tramways.

To those accustomed only to the feeble crawl of horse tramways—pounding along at the enormous velocity of three to four miles an hour—it seems impossible that there should ever arise any danger of serious collisions between tramcars on dark nights, or in foggy weather, when running on a single track. The usual plan is for one to wait at a fixed turn-out until the other one comes, and sometimes the "wait" is considerable. With the introduction of electric traction, however, the entire service becomes speeded up, and the motor-men grow rather inclined to "steal a turn-out," especially if by any chance they should be late already. With frequent traffic and a more or less indefinite time table, it is, of course, advisable, if not necessary, to put in double track; but narrow streets may forbid this, and consequently the fact must not be forgotten that much greater care will need to be exercised with fast-running electric cars against the danger of collisions on the line than is now the case with horse traction. Several of these accidents have already taken place in the United States, though from the particulars published it would appear that sheer recklessness on the part of one or other (perhaps both) of the motor-men has been the cause of what should be termed "incidents" rather than "accidents." With a more serious loss of life than has hitherto been the case, they will become "catastrophes," and by that time tramway managers will make proper rules for their *employes* and see that they are carried out.

AN ELECTRICAL HYPOTHESIS FOR THE SOLAR AND PLANETARY SYSTEMS, AND SOME OF THEIR ASSOCIATED PHENOMENA.

By DELTA.

(*Continued from page* 141.)

III.

Coincidence of Sun Spots with Magnetic Variations

Reference is made in the first article to the coincidence of sun spots with magnetic variation; fig. 8 shows the coincidence in graphic form.

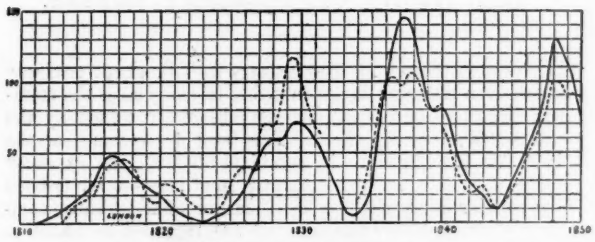
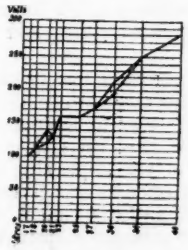


Fig. 8.—Sun Spots and Magnetic Variations (From Langley's "New Astronomy").

In the diagram, for which we are indebted to Mr. Langley, the amplitude of the oscillation of the magnetic needle is shown by the dotted line, the full one being constructed from the relative number of spots.

Further Evidence of the Increase of Electrical Potential with Increased Distance from the Earth's Surface.

Diagram, fig. 9, shows graphically the result of experiments made by Exner* with small balloons, with collectors in in open and free air.



Distance from the earth.

Fig. 9.

The same experimentalist obtained much higher result from observations made on the side of a mountain, *vid* diagram, fig. 10.

Methods and Apparatus for Examining the Electrical Conditions of the Earth's Atmosphere.

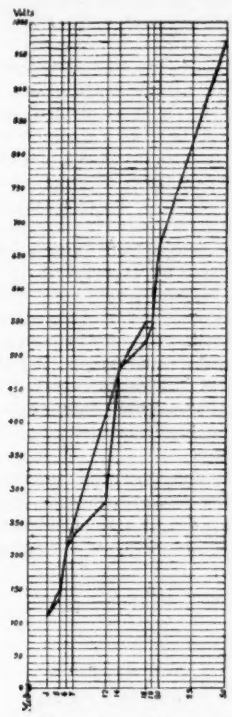
There should be little difficulty in devising means for the determination of the variations of electrical potential in mountainous districts, so that the barometric and electrical and thermal gradients can be recorded from day to day.

In France most excellent use has already been made of the Eiffel tower for the determination of the vertical barometric gradient. Here in England, unfortunately, we have no structure of equivalent altitude that can be readily employed for observative purposes, and we must, therefore, regret that the Wembley tower has not yet been completed.

In the absence of structures of high altitudes an alternative method has quite recently been employed, and with the best results as far as it was applied to the determination of barometric and thermal gradients.

This apparatus is shown by illustration fig. 11, and for which we have to thank *La Nature*. It will be seen to consist of a closed basket suspended from a kite of suitable carrying capacity and containing instruments of great precision and sensitiveness, and made of aluminium, for recording temperature and registration in mid air.

The apparatus registers variations of pressure of a fraction



Distance from the earth.

Fig. 10.

of a milim., and variations of temperature down to one-third of a degree centigrade. A check on the exact altitude can be trigonometrically determined by taking from two stations separated by a proper basis, two or more sights and their corresponding vertical angles, it is easy to determine the difference that exists between the height of the kite deduced from the barometric variation and the altitude determined mathematically.

The kite apparatus could be supplied with a multiple quadrant electrometer, with an automatic equipment for

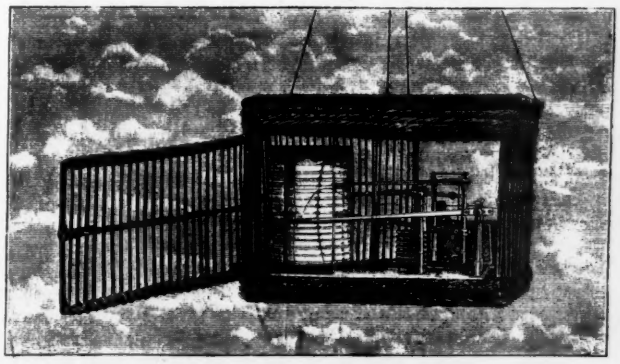


Fig. 11.—Aluminium Registering Apparatus for Studying the Vertical Gradient.

continuously recording the changes in the electrical condition of the atmosphere.

A suitable electrometer would record the myriad upon myriads of electrical lightning flashes, whose intensity is too slight to become luminously visible to the human eye.

It has also been suggested that Hertzian resonators, properly tuned, could be devised of sufficient sensitiveness to indicate all lightning discharges.

D

* Ursache und Gesetze der Atmos. Elec.

Proposed Conference of Experts.

The proper equipment of a perfectly equipped meteorological station that could satisfy the requirements—that the still almost unknown electrical condition of the atmosphere calls loudly for—is a subject that deserves the consideration of a joint conference of experts in the electrical, meteorological, astronomical, physical, and medical sciences.

The Determination of the Electrical Potential Necessary to Produce Lightning Flashes.

The importance of a concentrated attention into the electrical condition of the earth's atmosphere could not be overstated. Even Kelvin, a student of over half a century, is still compelled to rely upon assumption in building up a calculation of the electric density and force of a given enclosure, representing a given displacement of air.

He says, on the assumption (which he is compelled to admit may be proved by experiment to be untrue), that electric density is uniform throughout the spherical shaped enclosure, each cubic centimetre of air experiences an electrostatic force towards the boundary in simple proportion to the distance from the centre and amounting at the boundary to nearly 10 per cent. of the force of gravity upon it.

Kelvin suggests the following form of calculation to obtain some measure of the electric density and force of a specific atmospheric enclosure.

Where v equals the potential indicated by the water dropper, a equals the radius of the spherical hollow (displaced by the water drop), ρ equals the electrical density of air at the distance r, from the centre of the spherical hollow; then we have

$$v = 4\pi \int_0^a \left(\frac{r^2}{r} - \frac{r^2}{a} \right) dr,$$

if ρ is constant

$$v = 2/3\,\pi\,\rho\,a^2$$

$$\rho = 3\,v/2\,\pi\,a^2.$$

Suppose $v = 38$ volts*

$$\therefore \quad a = 50 \text{ cm. and } \rho = 2{\cdot}4 \times 10^{-5}.$$

The electrostatic force at a distance r being

$$4/3\,\pi\,\rho\,r = 10^{-4}\,r.$$

If we assume that a spherical conductor charged electrically—with a value of electricity equal to that possessed by a cubic centimetre of air—and placed at a point midway between the centre of the sphere and its surface, then $\frac{50}{2} = 25$ is equal to half the radius a.

Then between the surface and the centre of the enclosure, representing a given air displacement, there will be experienced a force equal to $2{\cdot}4 \times 10^{-9} \times 25$, equivalent, approximately, to $6{\cdot}10^{-8}$ grammes, or 4·8 per cent. of the force of gravity on a cubic centimetre of air of a density of 1/800.

Kelvin† applies this calculable hypothesis to the estimation of the electrical potential of a cloud constituted of air and watery spherules.

He says: "If a uniformly electrified globe produces a difference of potential of 38 volts between its surface and its centre, a globe of a kilometre diameter electrified to the same density reckoned according to the total electricity in any small volume (electricity of air and of spherules of water), would produce a difference of potential between its surface and its centre of 38,000,000 volts."

Kelvin, on this hypothesis, estimates that in a thunderstorm flashes of lightning show us differences of potential equal to millions of volts, but not as he says, perhaps of many times 38,000,000 volts, between places in the atmosphere distant from one another by half a kilometre, equal to 0·31 of a mile.

According to Trowbridge, to drive a spark across a gap between two terminals 4 feet apart requires a voltage potential of no less than 1,200,000, therefore a discharge of lightning one mile long will require the enormous pressure potential of over 100,000,000 volts; therefore 0·31 of a mile would require 31,000,000 volts, which is not far from Kelvin's calculated results. The voltage figure taken in the calculation is, however, rather too low, as is proved by Exner's determinations, see diagrams 9 and 10.

* See diagram, fig. 7, Electrical Review, page 140.

† See Kelvin's paper, *Proceedings* British Association Meeting, 1894.

The Movement of Freely Suspended Conductors of High and Low Potential in the Atmosphere.

McAdie makes the ingenious suggestion based on the well known fact that as the aluminium needle of the ordinary Thomson electrometer always moves from the region of high + to the region of low − potential, therefore a charged body, freely suspended in the atmosphere, will move from the place of high to the place of low potential. This may explain the movement of charged electrical conductors such as clouds, and thus produce the coloured aggregation effect, a common phenomenon of cloudland.

CONDITIONS OF TRAMWAY LEASES.

It seems customary in this country to talk about tramway *leases*, even although it is a fact that in many cases the tramways are not leased at all, but are absolutely owned by the companies operating them. The fatal 43rd clause of the 1870 Act has however—in combination with the excessive spirit of socialism that has sprung up of late—so far imbued the popular mind with the brief nature of a tramway company's life, that they one and all are regarded as liable to early extinction; they are not, as the Americans say, "franchises"—involving almost absolute freedom for a long, if not an indefinite time—but are merely short "leases" or tenancies which will be terminated as soon as possible in favour of the local authorities concerned.

The latter have had their appetites in this direction considerably whetted by the development of electric lighting, and if only to help make their electricity works pay better, they will seize every opportunity of taking over the tramways and working them, or at least supplying current for them.

There are, however, very many existing interurban and other lines (whose number will without doubt largely increase) where the local authorities are practically obliged to grant fresh leases; and there are also the new lines projected as tramways or light railways which have similarly to be dealt with in regard to eventual taking-over by the local authorities.

It is much to be regretted that in such instances our local authorities are too little inclined to learn from the experience of others, but simply trust to their own crude and ignorant ideas of what is the most advisable course from their own very narrow point of view, squeezing all they possibly can out of the tramway interests and giving nothing in return. Such short sighted methods cannot be too strongly condemned: we do not advocate perpetual rights for tramways such as are common in the United States, but for a local authority to have the option of taking over a private tramway enterprise at break-up value, after a life of 20 or even 30 years, is as ridiculous as it is unfair and impolitic.

Such a condition simply means that the tramway is starved by its management, no public benefits are or can be offered, and no good is done to anyone, simply because the local authority is afraid of even a limited monopoly, and the tramway company regards the public body as a band of duly accredited robbers who steal not for private gain but for the public good.

If inquiries were made of other countries before imposing conditions of lease or franchise in regard to tramway lines, it would, we believe, result in valuable information being brought forward of a nature, if acted upon, to give satisfaction on all sides. For instance, the average "life" of a tramway on the Continent will probably be found to extend over 40 or 50 years at least, though, of course, the conditions of road maintenance, money payments, &c., vary in each case, and therefore also vary the value of the concessions apart from their actual length.

Some very interesting and useful particulars in regard to this question are contained in a pamphlet that has just reached us from the municipal engineer of Shanghai, Mr. Charles Mayne. This gentleman appears to have circulated a list of questions amongst the principal local authorities of the United States and Canada, as to the period of years for which tramway concessions have been granted; the amounts

payable to the local authorities by the tramway companies for the right of user in regard to the public streets, and the works of paving, road maintenance, &c., to be carried out by the tramway companies.

Out of a total of 34 towns and cities ranging in population from 20,000 to 700,000, no less than 23 have granted perpetual rights to the tramway interests. One other system is almost as well off with a life of 999 years, another exists for 99, two for 30, two for 25, and four for 20 years; most of the short terms being granted by Canadian towns, so that we may credit the "public authority ownership" idea with being essentially British. Twenty-two out of the entire number pay the local authority in each case absolutely nothing for the privilege of using the streets, and 20 out of these 22 have a perpetual franchise. The other two are limited to 20 and 25 years respectively.

The majority are called upon to pave and maintain the roads, &c., between the rails and for 12 or 18 inches outside; but these conditions vary a great deal in each case, and no valid comparison can be made, but enough is given to show that English tramways suffer at present from disabilities of a much more serious nature than those inflicted by local authorities in any other country where tramways have developed at all.

PRACTICAL WORK WITH THE BALLISTIC GALVANOMETER.

By LAWFORD H. FRY.

The reflecting ballistic galvanometer has an unpleasant reputation for absorbing a great deal of time and temper in the making of measurements with it. A certain amount of this reputation is deserved, for the charting of the various ballistic constants, involving, as this does, a series of determinations of the coefficients of damping for different resistances in the galvanometer circuit, and their insertion in the somewhat unpleasant formula,

$$C_B = c\,\frac{T_0}{\pi}\,k\left(\frac{1}{\pi}\tan^{-1}\frac{\pi}{L}\right),$$

is necessarily a lengthy proceeding. But this need only be done once, and by the adoption of the methods given below, work with the ballistic galvanometer will lose much of its slowness. In the formula above, the symbols have the following meanings:—

C_B is the so-called ballistic constant, which varies with the resistance in the galvanometer circuit, and which comes from the formula, $Q = C_B \cdot \alpha$, where Q is the quantity of electricity flowing through the galvanometer, and α is the corresponding deflection.

c is the ordinary constant of the galvanometer.

T_0 is the time of swing of the galvanometer in an open circuit.

k is the coefficient of damping of the galvanometer, and may be defined thus: if $b_1, b_2, b_3, \ldots b_n, b_{n+1}$, be the amplitudes of successive swings of the galvanometer,

$$k = \frac{b_1}{b_2} = \frac{b_2}{b_3} = \ldots = \frac{b_n}{b_{n+1}},$$

$$\text{hence} \quad k^n = \frac{b_1}{b_2} \times \frac{b_2}{b_3} \times \ldots \times \frac{b_n}{b_{n+1}} = \frac{b_1}{b_{n+1}},$$

$$\text{therefore} \quad \log. k = \frac{\log. b_1 - \log. b_{n+1}}{n},$$

L is the natural logarithm of k.

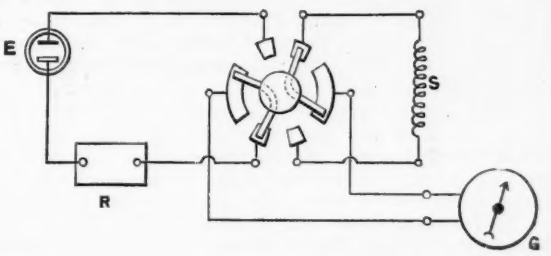
From this we see that, so long as the magnetic part of the instrument remains unaltered, the only factor in the formula that can change and alter the ballistic constant is the ordinary constant of the galvanometer, which will be altered by the shifting of the telescope and scale, which is a thing very likely to occur. Then to work in the most economical way, things must be so arranged that for the recalibration of the instrument the only measurement to be made is the determination of the ordinary constant. To accomplish this, a chart of the changes in the factor,

$$k\left(\frac{1}{\pi}\tan^{-1}\frac{\pi}{L}\right)$$

of the ballistic constant must be made and preserved; this factor changes with a change of resistance in the galvanometer circuit, but is unchanged by shifting the telescope. The form of this chart will be a curve having as its abscissæ the resistances in the galvanometer circuit in ohms, and for its ordinates the values of the expression,

$$k\left(\frac{1}{\pi}\tan^{-1}\frac{\pi}{L}\right)$$

Then to recalibrate the galvanometer all that will be necessary will be to determine the ordinary constant for the then position of the telescope, and to multiply it by the value of the other factor obtained from the curve by measuring the length of the ordinate to the curve, which passes through the point on the axis corresponding to the resistance of the galvanometer circuit with which the measurement is to be made. If, however, such a chart is not in existence and the ballistic galvanometer is to be used for some measurement, as for instance, the determination of the coefficient of mutual induction of two conductors, the following method will



enable the instrument to be calibrated and the measurement to be made with as small an expenditure of time as may be. The idea of the method is to determine the ballistic constant for the one galvanometer circuit resistance with which the final measurement is to be made. For such a determination the following quantities have to be measured. The ordinary constant of the galvanometer, c, the time of swing of the galvanometer in an open circuit, T_0, and the coefficient of damping of the galvanometer for the circuit with which the final measurement is to be made, k. These first measurements will be best made in the order in which they have been enumerated. In all work with the ballistic galvanometer it will be practically necessary to have two workers. In the present case we shall consider two men working as quickly as may be, so that one man changes the connections while the other is making observations; usually, however, speed will not be such an object but that it will be well to work out the results of each step before changing the connections to those for the next step, thus giving an opportunity for checking the work if the first result does not appear right.

To proceed with the measurements:

For the determination of the ordinary constant there will be needed a Clark element, or other standard cell, a resistance box containing resistances up to at least 30,000 ohms, and a two-way switch. These must be connected up, as shown in fig. 1, the switch allowing the galvanometer to be connected up in series with the element and resistance box, or to be short-circuited through the wire, S. This last is to bring the galvanometer to rest quickly between measurements, or if set swinging accidentally. The measurement of the constant is made in the usual manner.

If e be the E.M.F. of the cell,

r be the resistance in the box,

g " " " of the galvanometer,

C " current in the "

α " deflection of the " due to the current C,

and c " constant " "

$$e = C\,(r + g)$$

but $$C = c \cdot a$$

$$\therefore e = c\,a\,(r + g)$$

$$\therefore c = \frac{e}{a\,(r + g)}$$

now, e, r, and g are known, hence observing a gives c. With the ballistic galvonometer a steady deflection, a, can, of course, not be obtained; but the swing being noted the distance of the mid point of the swing from the zero of the scale gives a. This measurement having been made, the galvanometer must be set swinging sufficiently vigorously to enable the time of swing to be determined. This may be done by opening and closing the battery circuit periodically, the period being chosen to correspond to the swing of the instrument. Having set the galvanometer in motion, the switch must be turned open so that the swing continues undamped. Then to measure the time of swing. Measure the time taken for, say, 10 swings, divide the time by the number of swings, thus finding approximately the time of swing. Then let the galvanometer swing for a longer time, making, perhaps, 100 swings, note whether the number of swings is odd or even, divide the time by the approximate time of one swing as determined above, this will give the number of swings made during the whole time; the division will not give a whole number, but, of course, a whole number of swings has been made, here make use of the knowledge as to whether the number of swings was odd or even, if it was odd take the odd number nearest the quotient obtained by the division as the number of swings made, if, however, the number was even take the nearest even number, then divide the whole time of swing by the number of swings thus obtained. The quotient will be the accurate time of one swing. While one observer is watching the swing of the galvanometer, the other can be removing the element and resistance box and substituting for them the circuit in which the final measurement is to be made. To find the coefficient of damping of the galvanometer. Set it swinging, this may be done by sending the same current through which is finally to be measured, if this does not give a sufficiently wide swing several impulses may be given to help each other. The galvanometer being set swinging, turn the switch so that the galvanometer is damped by the circuit in which the final measurement is to be made. Note the amplitude of a number of successive swings, the number of swings will depend on the damping of the galvanometer, if the resistance is small so that the coefficient of damping is large, only a few swings will be wide enough to be read with accuracy, if, on the other hand, the damping is low, through a large resistance, more swings can be taken. Eleven swings will be found to be a convenient number to take, only the amplitude of the first and the last need be noted, for these are all that occur in the formula

$$\log k = \frac{\log b_1 - \log b_{n+1}}{n}$$

With 11 swings, n will be 10, a convenient number to divide by.

To avoid unnecessary work in the determination of the factor it will be well to obtain the value of

$$\frac{1}{k^{\frac{\pi}{L}}} \tan^{-1} \frac{\pi}{L}$$

by interpellation, from the accompanying table, which is taken from Kohlrausch, Leitfaden der Praktischen Physik.

The advantage of using the circuit in which the final measurement is to be made, in the determination of the damping coefficient, is that then only the one measurement of this coefficient is necessary, and no measurement need be made of the resistance of this circuit; thus a possible source of error is avoided, and a considerable amount of time and trouble is saved. The operations described above give all that is needful for the calibration of the galvanometer.

The use of a standardised induction coil will reduce the trouble and calculation in the determination of the ballistic constant to a very small quantity.

For if M be the coefficient of mutual induction between the spools of the coil,

C the current in the primary spool.

e_m the E.M.F. induced in the secondary spool by the disappearance of the current C.

c_m the current in the secondary spool.

t the time of change of current.

Q the quantity of electricity flowing through the secondary spool, and

R the resistance of the galvanometer circuit,

then $$e_m = \mathrm{M}\frac{dc}{dt}$$

and $$e_m = \mathrm{R} \cdot c_m$$

$$\therefore \mathrm{M}\frac{dc}{dt} = \mathrm{R} \cdot c_m$$

$$\therefore \mathrm{M} \cdot dc = \mathrm{R} \cdot c_m \cdot dt.$$

$\therefore$ By integration $$\mathrm{M} \cdot c = \mathrm{R} \int c_m \cdot dt$$

but $$\mathrm{Q} = \int c_m\,dt$$

$$\therefore \mathrm{M} \cdot c = \mathrm{R} \cdot \mathrm{Q}$$

again $$\mathrm{Q} = c_B \cdot a,$$

$$\therefore \mathrm{M}\,c = \mathrm{R} \cdot c_B \cdot a$$

$$\therefore c_B = \frac{\mathrm{M} \cdot c}{\mathrm{R} \cdot a}.$$

Hence, if M and R are known, all that is needful for the determination of the ballistic constant is the measurement of C and the observation of a. That is by the use of a standardised induction coil, the determination of the ballistic constant may be effected by a simple current measurement and mere multiplication and division.

Table.

Log k.	$\frac{1}{k^{\frac{\pi}{L}}} \cdot \tan^{-1} \frac{\pi}{L}$	Log k.	$\frac{1}{k^{\frac{\pi}{L}}} \cdot \tan^{-1} \frac{\pi}{L}$
00	1·0000	·13	1·1510
·01	1·0115	·14	1·1626
·02	1 0231	·15	1·1743
·03	1 0347	·16	1 1859
·04	1·0463	·17	1·1975
·05	1·0578	·18	1·2091
·03	1·0694	·19	1·2208
·07	1 0811	·20	1·2324
·08	1·0927	·21	1·2440
·09	1·1044	·22	1·2555
·10	1·1160	·23	1·2670
·11	1·1277	24	1·2785
·12	1 1393	·25	1 2900

In the final measurement for which the galvanometer has been calibrated as above, it will be advisable to leave in the two-way switch, with a short circuit between two of the terminals, as this affords a very handy means of bringing the galvanometer quickly to rest between the measurements.

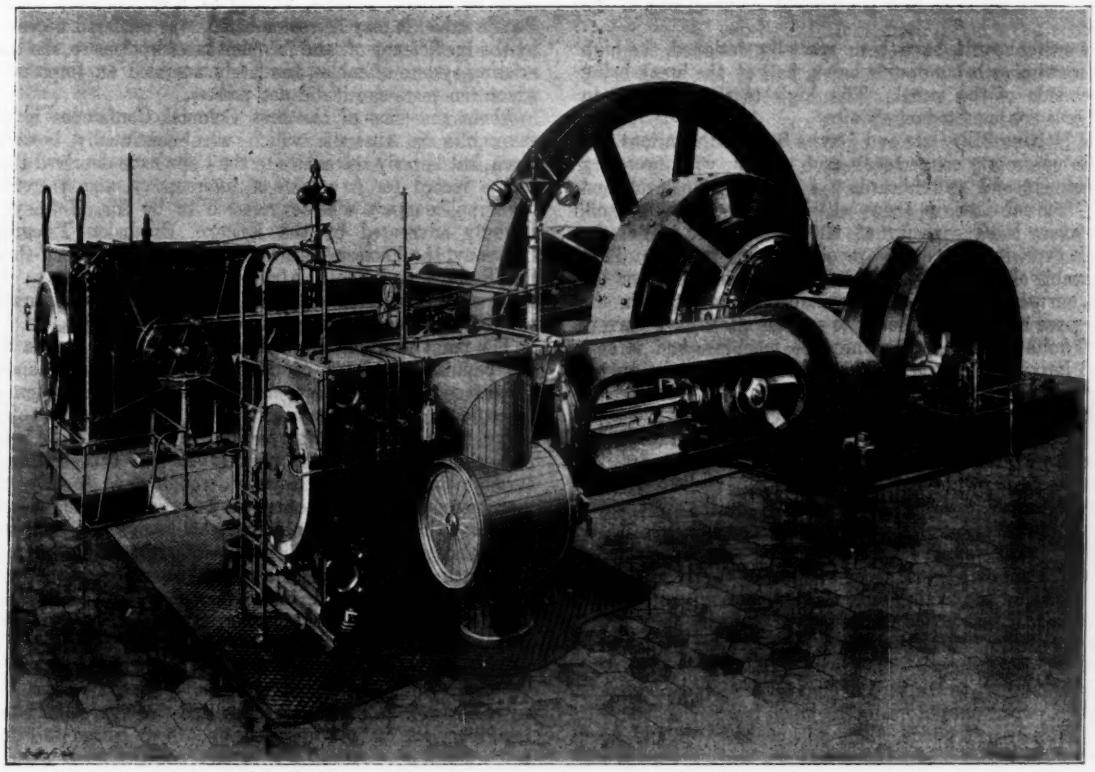
THE CENTRAL LONDON RAILWAY.

Great progress has been made with this gigantic undertaking, and last week of the total length of 22,880 yards of tunnelling, only 6,000 yards remained to be driven. Few people realise the enormous difficulties that have arisen in driving the tunnels. The work has necessitated not only the diversion of the sewers in many places, but round about the Bank the whole of the gas and water pipes had to be taken up and placed in different positions. Up to the present the energies of the railway company have been mainly directed to completing as far as possible that portion of the line that lay outside the City boundaries, and this to some extent, though not all, accounts for the somewhat backward state of the Bank subways. The foundations of the company's generating station at Shepherd's Bush have been begun, and no doubt this section of the undertaking will be completed about the same time as the other. It is perhaps hardly necessary to remind our readers that all the station lifts, some 49 in number, will be worked by electricity. On other electric lines in London the engineers have favoured the hydraulic system, and it will be interesting to compare the performance of the two methods.

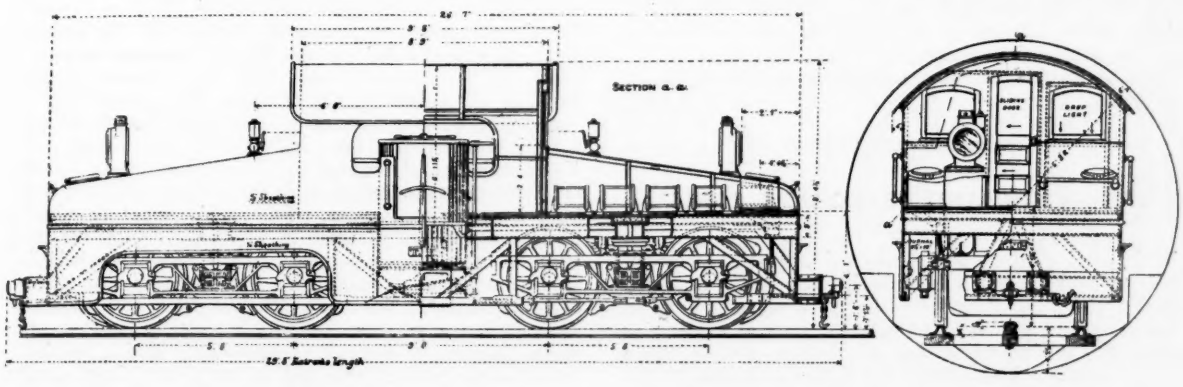
We are able to give a few interesting details of the plant

which is to be used on the line. The total length of continuous railway over which electric traction is to be provided, is about 6½ miles, exclusive of crossovers at stations and sidings.

It is intended to run a 2½ minutes' service, with trains of seven carriages each, with a total seating capacity each of 336 passengers, and weighing 105 tons loaded, exclusive of the locomotive. The average speed of the trains is to be 14 miles per hour, including stoppages at stations.



The electric plant, which is to be installed by the British Thomson-Houston Company, is on the three-phase system, and has been designed by their consulting engineer, Mr. H. F. Parshall. There are to be three sub-stations in the lower portion of the lift shafts at the Davies Street, Notting Hill Gate and Post Office stations. Additional plant is to be installed at the Marble Arch station, but will at present be only of the nature of a spare plant.



The boiler plant will consist of 16 Babcock & Wilcox boilers, in eight batteries of two each. The evaporating power of each boiler is to be 12,000 lbs. per hour; the heating surface 3,580 square feet, and the pressure 150 lbs. per square inch. The boilers will be fitted with Vicars mechanical stokers, which will be supplied with coal by a conveyor from a storage tank on the top of the boiler house, having a capacity of 1,500 tons. The coal conveyor also serves to remove the ashes, and will be driven by electric motors.

Each engine is supplied with an independent combined jet condenser and air pump of sufficient capacity to take the maximum quantity of steam. The condensing and injection motor will be forced to the top of four Barnard cooling towers, each tower being furnished with two fans driven by electric motors. The engines are six Reynolds-Corliss cross compound condensing engines running at 94 revolutions per minute, to give 1,300 I.H.P. each, with cylinders 24 inches and 46 inches diameter × 48 inches stroke. The engines are capable of being run non-condensing, and either high or low pressure side can be run independently. Steel fly-wheel is to weigh 100,000 lbs, and is built up in eight segments. The engines are guaranteed for a consumption of 13½ lbs. of steam at 1,000 I.H.P. when run condensing with 26½ inches vacuum. We are able, by the courtesy of Mr. Blackwell, who represents the makers, the

Edward P. Allis Company, in this country, to give an illustration of the exact type of engine which is to be employed.

The three-phase generators will have 32 poles, and a capacity of 850 kw., 500 volts, and 25 cycles. They are of the revolving field type. The coils of the stationary armatures are held in slots, there being ventilating ducts through the body of the armature, similar to the standard armature construction of the British Thomson-Houston Company. The total weight of each generator is 80,000 lbs. It is assumed that four of the six units will be sufficient to take care of the average load, and this will, therefore, provide a margin of 50 per cent. over the present requirements of the plant.

The switchboards have been specially designed, the high tension switches being double break, half of the break being on each side of the panel. The high tension contacts in every case are mounted on ebonite.

The Notting Hill Gate and Davies Street sub-stations will contain one rotary converter in each station, with necessary transformers and switchboards. At the Marble Arch and Post Office sub-stations, there will be two rotaries in each. Each rotary has a capacity of 900 kw., and will be of the 12-pole type, running at 250 revolutions per minute. They are capable of being run up either from three-phase, or the direct current side. As these are rotary converters in the exact sense of the word, that is to say, an alternating current of 330 volts pressure, passes into the machine, and is converted into a continuous current of about 500 volts on the other side, it is necessary to provide step-down transformers which reduce the line potential from 5,000 volts to 330 volts. These are of the air-blast type, but instead of following the usual plan of forcing the air through the transformers, the air is drawn through, and the hot air is expelled through sheet-steel pipes, running up the centre of the spiral staircase of the stations, thus providing ample ventilation for the sub-stations, as well as effectively cooling the transformers. The weight of each transformer will be 8,000 lbs.

The cables connecting the power-house with the sub-stations, will be carried through the tunnels on brackets. They are of the British Insulated Wire Company's standard paper insulation type. The third rail will be of steel, weighing 80 lbs., to the yard of channel section supported on creosoted wood insulators, each joint being bonded with four flexible crown bonds. The rails of both up and down lines will be divided into four sections, and interconnected by circuit breakers.

The locomotives, of which drawings are shown on the previous page, will be mounted on two trucks, each truck carrying two motors of 150 H.P. The total weight of the locomotive is about 42 tons, the total length of locomotive being 29 feet, and the total height, 9 feet 8 inches.

There will be four gearless motors on each locomotive, one on each axle, and these will be controlled by series parallel controllers, provided with magnetic blow-out, which will place the four motors in series, two in series, and two in parallel, or all four in parallel, as desired.

The trains will be fitted throughout with Westinghouse air brakes.

THE EMPIRE AND TELEGRAPH CABLES.

In the varying accounts of a new and important scheme of telegraph cables, which have lately been widely circulated among the press, throughout the Colonies as well as in England, there is to be found sufficient internal evidence to warrant us in concluding that all of these emanate from a single source. Although differing somewhat in the manner in which the statements are presented, as well as in the style of treatment, still, in the main body of these paragraphs and articles, the recurrence of the same prejudiced and garbled statements all point to a common source of origin. We have frequently dealt in detail with the numerous points raised, but, as the subject has assumed a more interesting aspect lately, owing to the aggregation of errors which are now being so widely disseminated, it is, perhaps, well that the more important of these should again be treated of at the present time.

The subject of a system of submarine cables, which, starting from England, would be carried on to Cape Town, touching only at the various British possessions on the way, is not a new one, nor is the proposed continuation of such a line from Natal to Australia, *viâ* Mauritius, Rodriquez Island, and the Keelings, a new conception. A somewhat similar scheme was fully dealt with by Mr. Hofmeyr, when representing the Cape of Good Hope at the Imperial and Colonial Conference, held in London in 1887; and was recommended by him as an addition to the scheme for a cable across the Pacific Ocean from Canada to Australasia, which was one of the principal subjects before the Conference. This additional scheme, which, as a supplement to the Pacific cable, it may be remembered, was rendered necessary by the inefficiency of, and frequent interruptions to, the then existing system of cables, has lately assumed an importance which ten years ago it did not possess.

About the time of the first Colonial Conference it was the cables to Australia which were continually breaking down, but latterly the cables to the Cape have deprived them of the record for frequency of interruption, and, therefore, the supplementary scheme referred to by Mr. Hofmeyr is strongly advocated by the Eastern Extension Telegraph Company, the Eastern Telegraph Company, and its off-shoot, the Eastern and South African Telegraph Company; the latter of which suffers both in purse and reputation owing to the frequency of interruptions to the Cape cables.

The point to which we take most serious objection, is that the popular advocates of Mr. Hofmeyr's project hope to advantage their cause by a continuance of the system of inaccuracy in figures and statements advanced, and by so doing to prejudice opinion against the Pacific cable route. For example, it used to be roundly asserted that the depth through which a Pacific cable would have to pass was "estimated at 12,000 fathoms (or 14 miles) in some places." This assertion was contained in a note from the Postmaster-General of South Australia to his Government, and coming from such a source aroused a natural objection on their part to examine any further into the matter; more especially when the same authority further asserts, in the same note, with a courageous confidence worthy of a better cause, that "as the Government are aware, I have given this subject very great and careful consideration, more so, perhaps, than anyone else." We are glad to see that this figure (an utterly imaginary one) is now reduced, by others better informed, to "a depth of 5 miles"; it is not, however, made clear by these recent critics, that this latter depth (which really does exist) occurs in an isolated depression which is more than 600 miles away from the proposed Pacific cable route. We may mention here that there are two cables lying in West Indian waters which were laid within 60 miles from a similar depression, more than 4½ miles in depth, and one of them has been working for over 25 years without giving any exceptional trouble. An unbiassed examination of the Admiralty charts will prove to anyone, that along the proposed route of the Pacific cable, the general depth to be expected in the deepest sections averages about 2,700 fathoms, and that the greatest depth would in all probability not be more than 3,200 fathoms —a depth, we may say, no greater than that in which a cable has recently been laid between New York and Hayti, and about the same as that met with along the line of the Government-supported cable which has just been laid from Bermuda to Jamaica. The Pacific cannot, therefore, be looked upon as an ocean of impossible depths, nor one where a cable cannot be picked up if necessary; indeed, experience teaches us that a cable has been picked up at the depth mentioned. The route sketched out *viâ* the Cape to Australia has, as yet, been but very imperfectly surveyed it seems, however, to have an average depth similar to that through the Pacific Ocean, and in one place at least, along the Cape line, there is a depth of nearly 3,200 fathoms. Thus it will be seen that, as regards depth of water, the supplementary route has absolutely no advantage over the Pacific line.

It is true that a cable between Vancouver and Fanning Island would be longer than any one length suggested for the supplementary route, but the length required would exceed by less than 250 miles that of a cable at present being laid across the Atlantic; and would in reality be about 250 miles less in length than the advocates of the Cape route make it out to be. The following quotation from an Australian

paper is another sample of the class of information circulated. Referring to the Vancouver-Fanning Island section, we are told: "This section is practically twice the length of the longest section of the 'Cape' proposal." Now, this is an utterly misleading statement, as the real length of the section spoken of is here increased, for the purpose of condemning it, by some 1,200 miles. As the writer in this case illustrates his article by a map on which the proposed lengths of "the Cape route" are all carefully set down, it seems incredible that he should be so ignorant, as he would appear to be, regarding the original scheme, which he criticises adversely. It has also been said that being a "single line" the Pacific cable has no alternative in case of interruption, but those who, in their anxiety to furnish objections, advance this as an argument, seem to forget that, if correct, the same objection also applies to the proposed single line from the Cape; and that should either of these single lines break down the already existing cables to Australia would afford more or less useful alternatives to one, as much as to the other, of these proposed single lines.

(*To be continued.*)

THE INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting of the Institution of Electrical Engineers, held on Thursday last, February 24th, Mr. G. Binswanger Byng read a paper on "The Manufacture of Lamps and Other Apparatus for 200-Volt Circuits." The author must have given to this paper a good deal of trouble and thought, and it is apparently written with a view mainly to arrive at some standardisation useful to manufacturers. Those who note the points in the different sections and discuss the views held by the author, are certain to help the object which he has had in view, and will benefit not only the members of the Institution but all electrical manufacturers.

We hardly agree, however, with Mr. Binswanger Byng that station engineers are neither unanimous nor possess correlation of ideas as to the kind of fittings and accessories suitable for 200-volt circuits. On such matters as the desirability of ventilating fuse boxes, there may be divergencies of opinion; but the principle and more important details of design and construction are recognised and agreed upon, while experience has shown the wiring contractor—who, after all, is the most difficult person to move in the matter—that certain types of fittings will satisfy his client, the insurance office, and the supply company, as well as suit his pocket. Perhaps the most difficult thing to get to-day is a good long-break switch for currents above 5 or 6 amperes at 230 volts continuous, which combines the desiderata upon which a consensus of opinion exists. We trust, therefore, that switch and fuse design will receive more attention in the discussion than the mere question of high voltage *v.* low voltage.

The discussion was opened by Mr. Crompton, who, however, preferred to reserve his remarks until a later meeting, as these were to be confined to the arc lamp question, and he was not quite ready to speak. Mr. Boot, of Tunbridge Wells, took the opportunity of impressing the importance of minor matters, too often ignored, upon those present; one of these to which he attached importance as concerning manufacturers was the necessity of adopting standards in design, and keeping to them. One point he considered noteworthy is the undoubted economy effected in cost of cable required on a 200-volt as compared with a 100-volt job; and he had known of several cases where firms had made a mistake, and tendered for work under the impression that supply would be given at 100 volts, whereas, on this being corrected, and the pressure having been ascertained to be 200 volts, a revised offer at a reduced price had been made; the saving in cable more than compensating for the extra cost of fittings and lamps. While a standard length of fuse should be agreed upon for manufacturers to work to with different currents, where fuses are used on alternating circuits there is less necessity for great length than on direct current circuits.

This fact, although well known, does not seem to be so generally recognised as it might be. From the author's paper Mr. Boot thought one is rather led to infer that high voltage lamps are decidedly bad; that is, that it is impossible to make lamps as satisfactory all round as with lower voltages. He admitted the life of the former was not so long as the latter, also that the candle-power sometimes falls off rapidly, but the author had certainly made out a very good case for engineers using the Robertson lamps.

He considered that engineers would find that a good case had been made out for the adoption of the higher voltage. At Tunbridge Wells the supply had been changed entirely over, and the higher voltage generally adopted. It was a general practice to connect two 100-volt lamps in series, as many fittings allowed of this, and in a number of cases customers had two-light fittings, both lights being controlled by one switch. Cheap lamps were the rule nowadays, if those of 100 volts were wanted, as those discarded by 100-volt supply were to be obtained at a low price.

Mr. Mordey felt much obliged to the author for the mention of his name in the paper in connection with a type of fuse he had designed some years ago. He was afraid he had not had much experience with 200-volt lamps, but watched with very much interest the progress of their manufacture and use. He considered the author had done a great service in bringing up this subject at the present time, and regarded what was read as an excellent practical paper. In a few remarks on the specific resistance of carbon, he stated that this ought to be considered in relation to its specific gravity, differences in specific resistance have to do with the mechanical state of the material. An unflashed filament under the microscope showed itself to be a long string of cinder, and the particles were connected together in the fashion of what was, in the early days, called microphonic contacts. Flashed filaments become very much more a solid. On the first occasion he spoke at the Institution, in 1882 or 1883, experiments were cited, showing that carbon differed from metals in its behaviour, depending upon its mechanical state: finely-divided carbon behaves the same as finely-divided metal. It would be interesting to know if the pendulous filaments of carbon found in the gas retort of a gas-works, have been ever used for lamp manufacture, or if any attempts have been made to employ them.

Then advocates of high voltage supply must not forget that the question is practically being tried by jury, and speakers should give actual costs of different voltage lamps on circuit. Engineers must not imagine that the jury has been asleep; he had heard entirely unsatisfactory remarks from users of high voltage lamps, other advantages may balance the disadvantages; but the satisfaction of the public is the question. Central stations might take on their shoulders the whole burden, and thereby obtain control of the energy sent out for a given candle-power.

Mr. Mordey then referred to Mr. Robertson's paper in the Electrical Review, where the difference of effect of alternating and direct currents on the life of lamps was discussed. In Vienna, where the conditions enable reliable comparative tests to be made, it was found that there was a very decided gain where lamps were used on alternating circuits. There might be a commercial advantage in the supply of lamps to customers at a certain contract price.

With respect to arc lamps, his experience was that the getting out of the light from the arc was the important point, and with high volts the light gets out; but small current lamps at high voltage were very poor things, although even from a small crater the light can get out if the length of arc be considerable.

Mr. Binswanger Byng mentioned in his paper a novel "cut-out" for extinguishing the arc in an arc lamp automatically when required, but Mr. Mordey held that the cut-out in the old Brush lamp complies with all the conditions laid down.

Mr. Robertson stated that he had nothing to add to the information he had given the author when assisting him in the preparation of the section of his paper on incandescent lamps. Mr. Raworth thanked the author for his very excellent paper, and remarked that Mr. Boot and his friends would not be quite so happy if they had to make the lamps they use, or live with them. At the present time Mr. Raworth had to live with them, and had the opportunity of creating an enormously fine cemetery from the selections that lamp makers were good enough to send him free for trial. Some engineers state that they look for one in every dozen going wrong at the commencement of life,

but he had 25 per cent. in a dozen, and in another dozen only two were left. Certain of the peculiar qualities of high voltage lamps—such as not burning horizontally with satisfaction—were rather important things to consumers and contractors, where the angle at which fittings were set might have to be altered to obtain decent results. Another point is that these high voltage lamps do take more current per candle-power than the lower voltages, a rather important matter to the consumer who resents an increased bill for lighting.

Mr. Shoolbred believed that the 100 and 110-volt lamp in the early days of electric lighting was quite as much an experiment as the 200 or 220-volt lamp is at the present time, and felt sanguine that the latter will prove equally successful, owing to the very large number of indirect advantages attending its use. There are many things to be considered besides the lamps, such as motive power, &c., and 400—500 volts can be utilised in many applications of electrical industry besides lighting. The author referred to the difficulties he had met with; many of these were due to not having had the advantage of discussing the question of standard pressure at an earlier date, when an attempt might have been made to avoid the existing discrepancies. The opportunity was lost then, but it would have been very much better to have arrived at something like unanimity in the matter while possible. We may emerge from seeming chaos to the best in the end.

The results attained so far are by no means discouraging. The restriction to a small size of bulb need not always apply, and there seems to be no insuperable difficulty in using a larger sized cap, particularly in starting in new localities. A reversion to olden time again is the expedient of using two lamps in series. Many years ago two 50-volt lamps were so connected, to enable the best lamps then extant to be connected on a 100-volt supply.

In horizontal positions lamps of high voltage are weak, but anchored and zigzag filaments can be used, while Mr. Shoolbred had certainly not experienced much trouble with such lamps in a horizontal position.

At this stage the discussion was adjourned until the first meeting in the current month, which will be held on the 10th inst., and we may expect a lively and useful discussion. It might not be out of place to again point out that the title of Mr. Binswanger Byng's paper is practically precise, and his intention obvious; a much better purpose would be served by dealing with the paper than by roaming all over the subject of supply pressures, and repeating what has already been said at the Institution when Mr. Addenbrooke's paper was read, at the Municipal Electrical Association on Messrs. Barnard and Couzen's papers, and at the Northern Society of Electrical Engineers, when Mr. Gibbings described his procedure and experiences at Bradford with the increased pressure. It is really time that it was made clear to wiring contractors and consumers what precautions are essential, and in what particulars wiring must be altered from the old fashion when 200 volts pressure is to be used.

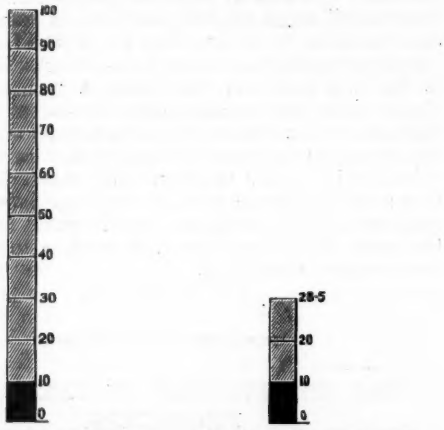
CORRESPONDENCE.

"The Burning Question."

Your recent articles on the above subject hardly do justice to the filter press as an aid in the burning of sludge. I notice calculations based on the assumption that the press removes one-third of the weight; and you have also expressed doubts whether sludge containing 65 per cent. of moisture can be considered pressed at all.

Now, 65 per cent. is not an excessive proportion of moisture in pressed sludge, and to reduce the percentage to this from the 90 per cent. in the original wet sludge requires the removal of about *two-thirds* of the bulk. The appended diagram (an old-fashioned affair now) will make this clear at a glance. The dark portion shows the solids, and the light portion the water. In the first case (unpressed) there are 90 parts of liquid to 10 of solids; in the second 18·5 parts of water to 10 of solids. That is to say, more than seven-ninths of the water have disappeared. If the solids are to be burnt, the press is plainly a valuable adjunct in the process—excepting always the case of Ealing.

Ordinarily, pressed sludge is not very combustible. You may drop a lighted match on a heap of it without any risk of a conflagration. Spontaneous heating does sometimes occur, running up the temperature to somewhere between



Unpressed Sludge with 90 per cent. of Water. The Same Pressed with 65 per cent. of Water.

110 and 120° F., and keeping it wonderfully steady at that for a considerable time. After heating and cooling there is a farther diminution in bulk; the cake formation is destroyed, and the heap becomes a mass of mere greasy muck.

Wet sludge has never been known to heat anywhere, and in most cases is about as combustible as Embankment mud on a wet day. At Ealing all this is different; the addition of a few cabbage leaves, meat-tins, and ashes confers remarkable burning qualities on the wet slop. It burns freely, and, after driving off its own moisture, has heat to spare, which is diligently utilised. No one has ever clearly explained the furious affinity for oxygen which characterises the Ealing sludge; some talk vaguely of dietic peculiarities of the contributory population, others of transmutation and the philosopher's stone. One had the theory that the solids consisted exclusively of potassium, but half an hour to leeward of the chimney stack dispelled that notion. The facts stand: ten parts of solids (and these mainly mineral and incombustible anywhere else) not only burn, not only evaporate nine times their weight of the water in which they were drowned; but they do these and yet have energy to spare for evaporating other waters, transformed later into mechanical and again into electrical energy, with effects visible to all men on the tops of arc lamp poles in Ealing Town. The old scientists used to dream about the circulation of matter, beginning, say, at the villager with a deal of guano in his destiny, who lay in the churchyard and made the grass grow. The churchyard fed the village sheep, the sheep the villager, and so the cycle went on. But what a poor figure these dreams make beside the realised results at Ealing. The natives live on the fat of the land; the dejecta, garbage, and refuse, elsewhere a costly nuisance, transformed into brilliant light; and all by mere cunning engineering and chemistry at the sewage works. Imagine this system applied to London—but we cannot.

J. Hetherington.

A Legal Point.

I should be pleased if you could kindly tell me whether the following action on the part of a corporation is legal or not, as it opens up a wide field:—

A corporation, with an electricity supply for the borough, has just secured an order for a large private installation outside their area of supply, and, in fact, in the area of an urban district council which has just got a provisional order. This corporation, I should mention, has its own wiring department, and the private installation is to consist of engine, dynamo, wiring, &c. My opinion is that this is illegal, as it is using ratepayers' money in a speculative business, quite outside the area of the borough.

Another point I should like to mention, and that is, the assistant engineer for this same corporation is at the present time acting as consulting engineer for two large private installations, thereby depriving consulting engineers, who are dependent upon it, of obtaining clients.

If the first instance is illegal, it will result, I understand, in the corporation being prosecuted, and a few words from you on the matter would, I feel sure, awaken interest in the subject, which, I think you will admit, is a serious one.

Legal.

[Although there may be some uncertainty as to the exact legal position of a corporation when undertaking wiring inside its own area of supply, there seems to be little doubt that a corporation is exceeding its functions when it undertakes wiring outside its own district. We do not think that much complaint can be urged against assistant engineers who do occasional consulting work, for it is doubtful whether their outside practice interferes very much with that of engineers who devote their whole time to consulting work.—Eds. Elec. Rev.]

Currents Necessary to Fuse Wires.

On looking over a table of above, taken from a paper by W. H. Preece, F.R.S. (*Proceedings Royal Society*, Vol. XLIV., March 15th, 1888), I noticed the following relations between the currents; and as they appear to have been overlooked hitherto, I thought they might interest your readers.

The following is part of the table in question :—

Wire—diameter in inches.	Cu. × 1	Fe. × 3	Sn. × 6	Pt. × 2	Pb. × 8	Al. × ⅓
0·080	231·8	71·22	37·15	117·0	31·20	171·6
0·064	165·8	50·96	26·58	83·73	22·32	122·8
0·048	107·7	33·10	17·27	54·37	14·50	79·75
0·036	69·97	21·50	11·22	35·33	9·41	51·18
0·028	48·00	14·75	7·69	24·23	6·45	35·53
0·022	33·13	10·27	5·35	16·88	4·49	24·75
0·018	24·74	7·60	3·96	12·49	3·33	18·32
0·014	18·44	5·66	2·95	9·31	2·48	13·66
0·012	14·15	4·34	2·26	7·14	1·90	10·47
0·010	11·50	3·53	1·84	5·80	1·55	8·51

You will notice that, approximately, the current required to fuse Pt. is one-half of that necessary to fuse Cu.; also, that necessary to fuse Sn. is one-sixth of that required to fuse Cu.; and similarly for the other elements, using as divisor, in each case respectively, the figure given under symbol in table. So that, in order to get the approximate fusing current for any one of those elements, all one requires to know is the fusing current for one of the particular wires and the multipliers.

There is also the somewhat curious fact that if the currents necessary to fuse a given wire of Fe., Sn., and Pt., respectively, are added together, their sum is, approximately, the fusing current for Cu. wire.

This, of course, follows as a mathematical deduction from the above.

I may mention that the currents in above table are in amperes, and that the wires are of such lengths that end effects may be neglected.

W. H. F. Murdoch.

Glasgow, *February 28th*, 1898.

Information Wanted.

I would be very much obliged if any person could inform me, that when designing a ring slotted armature if the section is calculated as if the slots were solid, or how is it calculated, or what allowance is made for slots?

Also, supposing the slots were a quarter of an inch wide, would the air space between armature and fields be one-eighth of an inch on each side, or what proportion of width of slot would the air space on each side be?

Subscriber.

Cost of Long-Running Plant.

I should be much obliged if you or your readers would let me know of any electrical plant running more or less continuously at or near full load. I am anxious to find out the cost of generation under these conditions, and should be glad to be put into communication with the owners of any such plant, whether used for electro-chemical or any other purpose. The plant need not be of large capacity necessarily, but the main feature should be that it runs for long hours at or near full load. I imagine there must be cases where such plant is run more or less continuously all the year round, and if so, I should be glad to know of its existence. The main difficulty seems to be that the owners of such plant object, on business grounds, to making their experience public; but I hope it may be possible to find some cases where such considerations do not hold.

Atlas.

The Salaries of Assistant Electrical Engineers.

I do not think that I am the only one of your readers who will heartily endorse the opinions of the two correspondents in your last week's issue with respect to the magnificent salaries now being offered for responsible positions in station work. I could a little understand the policy of the borough electrical engineers, if they were ever in the habit of considering the ratepayers by keeping down their own salaries, as well as those of their assistants. But I notice that, whether the place be paying or not, the salaries of the chiefs are going ever upward, while those of their staffs are going down. I do not think that these men, in doing this, are rightly keeping up the dignity of their profession. For do not they themselves belong to the same rank of the profession as they, and do not they expect their assistants to have gone through the same electrical training as themselves? If their respective committees think at all about this strange state of affairs, it must strike them that there is some unfairness in paying an assistant who is expected to be able to take the place of the borough electrical engineer in his absence, such a ridiculous fraction of his salary. Of course, the poor fellows have it all so nicely explained to them by the continual humbug, "Look what you are learning." But an assistant cannot continue everlastingly extending his experience for nothing, any more than a borough electrical engineer. In any profession, and especially in that of electrical engineering, a man is learning all his life.

There is no reason for this starving policy even in the case of the few non-paying stations. But it certainly ought not to be seen in a place which pays like Tunbridge Wells. Borough councillors do not expect the officials in their other departments to do work for nothing, and it ought not to be allowed in their electric light station. What would these gentlemen think of engineering firms who pay their skilled mechanics 25s. or 19s. 2¾d. per week? In most tenders a Corporation now expressly stipulates that the men must be paid the standard wage.

If the ratepayers' pockets must be considered in such a remarkable way, and if it is absolutely necessary for the profession that this grinding should go on, might I suggest that permission be obtained from the mayor and councillors of the towns where it is practised for boxes to be placed outside their public buildings with a legend such as this :—

"Electricians' Poor Box.

"As we only pay our assistant electricians enough for board and lodging, we should be glad of your help, so that they may provide themselves, in the interests of decency, with a little clothing. Remember that they work 365 days in the year, and that it is mostly night-work."

Fiat Justitia.

While sympathy for the writers of "Protests" against small pay to *shift engineers* fills my breast, I fail to see that there is sound "horse-sense" in the proposal of W. Fennell. There are dozens ready to pay for a chance at practical electrical experience, and your refusing to accept such advertisements would probably let others try to enter this overcrowded market, who may see these advertisements

and be deterred thereby, to our future advantage. I could tell of a small high tension station on this island whose chief engineer and manager accepted the post a few years ago on £2 a week, with the privilege of taking a pupil, and he got the pupil.

L. D. Collins.

Dublin Cables.

Referring to the note on "Dublin Cables" in your last issue, it is evident to me that you are not correctly informed as to the actual facts.

The statement that the arc light cables were too small is entirely without foundation, as 7/16 cable should be perfectly adequate for a current of 10 amperes, and the further statement that it was unsuitable for the mechanical strains it was called upon to bear from time to time is equally incorrect, as no interference was found necessary with these cables until the first breakdown occurred, some three years after the station commenced work.

With regard to your remaining remarks, I may say that the necessity of applying for a loan was due to the fact that the distributing system had repeatedly failed during the previous two years, owing to deterioration of the rubber insulation of the cables at many points, and when as many as 20 failures occurred during one week, it was impossible to preserve the proper continuity of supply to the consumers.

To remedy this state of affairs, it became necessary to lay down new cables; and as these could not be placed in the same pipes with the existing cables without disorganising the supply, it naturally resulted that the ground must be re-opened over the whole system to accommodate the new cables, and it was considered advisable to take advantage of this opening to change the system of distribution to the consumers from high tension supply with house transformers, to low tension supply from transformer sub-stations.

When the new system of mains is in complete working order, the existing system of pipes, &c., would be available for use in extensions as required, and such of the cable as should be found suitable would be used for the same purpose.

It is obviously impossible for anyone to know the actual condition of this cable over its whole length until it has been withdrawn and carefully examined; but from the observations I had made I considered that cable to the value of £2,000 should be found capable of being used, out of the total amount of £3,300 which had been expended in purchasing same, and I estimated that the cost of making such cable serviceable should not exceed £500.

In face of the above summary of the recorded facts, I am quite unable to see any foundation for your suggestion of inconsistency, and must request you in future to verify your facts before basing upon them any reflections upon my personal conduct.

M. Ruddle,
Electrical Superintendent,
Dublin Electricity Works.

[We are unaware of having made any reflections upon Mr. Ruddle's personal conduct, and if he will take the trouble to read through the report of the official Government Board inquiry on the city electric light, as published in the *Irish Daily Independent* for December 9th, he will surely admit that his own evidence was sufficient foundation for our note of last week.—Eds. Elec. Rev.]

Estimating, &c.

Could any of your readers inform me of a book on estimating for "mechanical and electrical plant and installation work," or how I could gain some experience of the subject.

A Subscriber.

Royal Institution.—The course of lectures on "Recent Researches in Magnetism and Diamagnetism," which Prof. Fleming commenced at the Royal Institution on March 3rd, are the "Tyndall Lectures."

DUBLIN ELECTRIC LIGHTING.

The following is a copy of the letter from the Local Government Board to the town clerk, conveying the decision of that body on the recent application of the Corporation for a further loan of £20,000, in connection with the existing electric lighting system:—

"Local Government Board, Dublin,
"*January 13th*, 1898.

"Sir,—I am directed by the Local Government Board for Ireland to state, for the information of the Corporation of Dublin, that they have received the report of their chief engineering inspector, Mr. Cotton, on the local inquiry, held by him on the 8th ult., into the application of the Corporation for sanction to a loan of £20,000 for works in connection with electric lighting. With regard to this application, the board wish to observe that in November, 1891, a loan of £32,800 was sanctioned for machinery, cables, posts, lamps, &c., for electric lighting, and £4,200 for buildings at the generating station. In November, 1893, a further loan of £16,837 was sanctioned for additional and extra cost of machinery, and £7,563 for cables, pipes, and laying. Of this latter loan only £5,000 was advanced. Recently, it appears, there have been many failures in the cables, and it was resolved by the Corporation to apply for a loan, which, among other things, would provide for laying these cables *de novo*. The Board observe that on September 23rd, 1897, the Electric Lighting Committee recommended that a new generating station should be provided at the Pigeon House Fort, at a cost of £100,000, and also—(2) That a system of sub-transformer stations be adopted. (3) That the entire system of cables or mains, so far as it may be found necessary by the borough surveyor, be altered or renewed. (4) That for the purpose of such renewal the sum of £20,000 be provided. The Council at their meeting on October 8th, adopted a report of the committee of the whole house, slightly varying the recommendations of the Electric Lighting Committee, including the following:—

"'That a system of sub-transformer stations be adopted, as such will ultimately prove a saving to the Corporation: that the entire system of cables and mains, so far as it may be found necessary, be altered or renewed; that for the purposes of such renewal the sum of £20,000 be provided, but that no portion of this amount be expended or orders given, until the description of cable be reported on by the consulting engineer with the borough surveyor to a committee of the whole house, to be called for that purpose, and approved by them; that the Electric Lighting Committee be empowered to apply to the Local Government Board for their sanction to a loan of £20,000, the law agent and the town clerk to take whatever steps are essential for this purpose.'

"On November 10th, 1897, the town clerk wrote to say that the Municipal Council have, on a representation from the Electric Lighting Committee, decided that it is absolutely necessary to have the cables renewed with as little delay as possible, and have therefore directed me to make application for the sanction of your board to a loan of £20,000, to enable the Corporation to proceed with the proposed work. This letter, of course, indicated that £20,000 was required to be spent in re-placing 'cables' which had failed, and the town clerk was informed that a loan to replace failures would not be sanctioned while the loans under which the works were constructed are running. The town clerk wrote again on November 23rd, 1897, to the effect that only a small portion of the £20,000 was required to purchase 'cables' to replace those that failed. Under these circumstances the Board considered it desirable to order the local inquiry, which, as already mentioned, was held by Mr. Cotton on the 8th ult. The town clerk's letter of November 23rd, 1897, and the evidence given at the inquiry, show that the £20,000 is proposed to be applied to two purposes:—1. For forming sub-transformer stations and costs incident on the change of system, say £6,500; 2. For new cables and laying, £13,500—£20,000. From the wording of the report of the committee of the whole house it might naturally be inferred that the whole £20,000 was required simply for the renewal of the cables which had failed. As regards the portion of the loan destined for sub-transformer stations, and costs incident thereon, the Board find that this change of system was recommended by Mr. Ruddle, in his report of September 18th, 1897, and was adopted by the Electric Lighting Committee, and by the committee of the whole house, and approved by the Council of October 8th, 1897. It was also recommended by Prof. Kennedy, in his report of October 25th, 1897, which report the Board are informed, has been approved of by a committee of the whole house. The estimate for this work, contained in the town clerk's letter of November 23rd, 1897, appears to be approximate only. The Local Government Board will be prepared to consider a loan for this purpose when full particulars, specification, and detail estimate are submitted and approved. As regards the rest of the loan which is required for new cables and works in connection therewith, the estimate is also approximate only, and no particulars or specifications have been submitted. The present cables insulated with vulcanised rubber are laid in pipes, and cost, so far as the Board can ascertain—For cables, £3,300; for pipes and road work, £8,000; (about) £11,300. The evidence shows that it would not be possible to draw out the present damaged cables and replace them in the same pipes with new cables without dislocating or stopping entirely the lighting arrangements over the whole area at present supplied. This circumstance, in the opinion of the Board, points to the advisability, in future works, of providing for duplicate mains. There appears, therefore, to be no remedy for the present state of things but to provide new cables, as suggested by Prof. Kennedy in his report, which, as stated above, has been before the committee of the whole house, and approved by them, in accordance with the resolution of the Council of October 8th, 1897. It is stated that the rest of the work, the pipes and works incident thereon, will not be rendered useless, but are available, and will be used for extensions to the further parts of the city outside the

present lighting area, and to provide duplicate means of supply as required in consequence of increased demands in future. The Local Government Board consider that a further loan for these cables may be entertained, but the amount should be limited by deducting from the amount required the sum properly outstanding in respect of the portions of the original loans appertaining to the cables which have to be replaced, the cost of which appears to be £3,300, of which about £2,600 is now properly outstanding. The balance (£2,563) of the second loan, not drawn, should be considered as cancelled. The Board do not consider that the suggestion that the present cables can be removed, and when repaired be again used, ought to be taken into consideration. When full particulars, specification, and detailed estimates are submitted and approved, the Board will be prepared to sanction a loan for new cables and works connected therewith.—I am, Sir, your obedient servant,

"(Signed) D. J. MacSheahan,
"*Assistant Secretary.*"

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending March 1st, 1897.	£	s.
Amsterdam	265	0
Barcelona. Teleg. cable	120	0
Bilbao. Teleg. mat. ...	86	0
Bombay	65	0
Buenos Ayres	18	0
Bundaberg	119	0
Calcutta...	276	0
Cape Town. Teleg. mat.	220	0
Christiana. Teleg. wire	86	0
Durban	597	0
East London	89	0
Flushing	13	0
Fremantle (400) ...	403	0
" Teleg. cable	730	0
" Teleg. mat.	3,982	0
" Teleph. mat.	1,553	0
Genoa. Teleg. wire ...	50	0
Gibraltar	110	0
Gothenburg. Teleg. wire	108	0
Malaga	85	0
Marseilles. Teleg. mat.	80	0
Melbourne	1,074	0
" Teleg. mat.	402	0
Ostend	104	0
Passages	80	0
Perth	111	0
Port Elizabeth	28	0
Rio Janeiro	70	0
Rotterdam	18	0
Santos	27	0
Shanghai	399	0
Singapore	80	0
Sydney	87	0
Wellington	1,130	0
" Teleg. mat.	434	0
Yokohama	283	0
Total ...	£14,379	0

Week Ending March 1st, 1898.	£	s.
Adelaide	23	0
Alexandria. Teleph. mat.	77	0
Antwerp	29	0
Auckland	18	0
" Teleph. mat.	2,740	0
Bangkok	447	0
Bombay	433	0
Boulogne	86	0
Buenos Ayres	520	0
" Teleg. mat.	127	0
Calcutta...	84	0
Cape Town	1,250	0
Constantinople ...	230	0
Colombo	100	0
Delagoa Bay	1,076	0
Durban	205	0
Flushing	25	0
Gibraltar	277	0
Lyttleton	2,297	0
Madras	10	0
Malta	72	0
Mauritius. Teleg. mat.	42	0
Melbourne	143	0
Passages	29	0
Port Elizabeth... ...	135	0
Reval	62	0
Shanghai	7	0
Singapore. Teleph. mat.	44	0
Sydney	1,726	0
Tientsin	31	0
Wellington	112	0
Yokohama	488	0
Total ...	£12,945	0

Foreign Goods Transhipped.

	£	s.
Rio Janeiro. Teleg. mat.	1,024	0

Appointment.—We learn that Mr. William Isaac Taylor, M.I.M.E., of 50, Fenchurch Street, E.C., has been appointed as the successor to the late Mr. Archibald Thomson, to represent the Darlington Forge Company, Limited, for London and South of England, for all work of their manufacture, with the exception of railway work. Mr. Taylor has represented Messrs. Clarke, Chapman and Co., Limited, of Gateshead, for the last 15 years, and this position he still retains.

Art Metal Fittings.—Mr. Charles Escare, of 16, St. Anne's Court, Wardour Street, Soho, send us an illustrated list of various designs of brackets, electroliers, switch covers, &c. Nearly all the designs shown are Louis XV. and XVI., and are exact copies taken from State castles and museums, and adapted for the electric light. The chasing, mounting, gilding and repairing, are carried out at St. Anne's Court.

Bankruptcy Proceedings.—A receiving order was made last week at the London Bankruptcy Court against Trehearne, Son & Crump, electrical engineers, 155, Fenchurch Street, City. Messrs. Montagu & Co. attended on behalf of the General Electric Company, Limited, Queen Victoria Street, the petitioning creditors. The act of bankruptcy alleged in the petition was non-compliance with the requirements of the usual bankruptcy notice. No particulars transpired regarding assets or liabilities.

Brussels Exhibition.—We understand that in addition to obtaining the gold medal at the recent Brussels Exhibition, the jurors have awarded a special prize of 1,000 francs for Geipel's patent steam trap in recognition of its exceptional merits.

Business Announcement.—Messrs. Henderson, Bunn and Co., Limited, of Giltspur Street, announce that they are placing upon the market an insulated iron armoured conduit for electric wiring, the insulation being porcelain enamel. The same firm is also introducing the H.F. dry battery.

Personal.—Mr. Joseph Bastick informs us that he has relinquished his electrical engineering business at Levenshulme, and has joined the Birmingham Carbide Company, Limited, as works manager, on a seven years' engagement, to erect the plant and superintend the manufacture of carbide. Mr. Bastick has been with Messrs. Crompton & Co., Swinburne & Co., John Turner & Sons, and other firms.

Calcium Carbide Plant.—We learn that Messrs. Ashton, Frost & Co., Limited, have on hand a dynamo (60 volts 2,000 amperes) four polar, with slotted drum armature and duplex winding, for the manufacture of calcium carbide in conjunction with Pictet's patent furnace, for Messrs. Carter & Lupton, Ingleton, who hold a license for the Pictet furnaces.

Change of Addresses.—Mr. Geo. Stegmann informs us that, in consequence of increased business, he has removed to larger and more commodious premises at 45, St. John's Hill, Clapham Junction. He will shortly open electric light showrooms, where every requisite relating to electric lighting will be on view.

Mr. J. S. Cunnington, electrical engineer, has removed from 18, Cecil Court, to larger premises, 93, St. Martin's Lane, W.C., in consequence of increased business.

Electrical Plant for Collieries.—During the general meeting of the Federated Institution of Mining Engineers in Newcastle a large number of members and delegates visited the works of Messrs. Ernest Scott & Mountain, Limited, at Newcastle-on-Tyne. The following is a list of electrical colliery plant and other machinery in course of construction and on view in a state of completion, ready for shipment, that was open to the inspection of the visitors:—For the Clay Lane Iron Company.—One set of 14 inches by 18 inches three-throw mining pumps capable of delivering 1,000 gallons per minute against a head of 300 feet. For the Arniston Coal Company.—One set of 14 inches by 18 inches three-throw mining pumps (high lift) capable of delivering 500 gallons per minute against a head of 750 feet. For Messrs. Rowley, Thomas & Co.—One set of 7 inches by 12 inches three-throw mining pumps (low lift) capable of delivering 200 gallons per minute against a head of 250 feet. For the Mitchell Main Colliery.—One set of 10 inches by 12 inches pumps capable of delivering 500 gallons against a head of 150 feet. For the Arniston Coal Company.—Two 200-unit generators for driving pumping machinery, and three 80-H.P. motors for driving pumping machinery. For the Hickleton Main Colliery Company.—Two 90-unit generators for driving electric haulage plant. For Young's Paraffin Oil Co.—Endless rope electric haulage plant with 40-H.P. motor, driven through worm gear. For the Digby Colliery Company.—Electrical coal-cutting machinery, fitted with disc of suitable diameter to cut 4 feet 6 inches deep, and with motor of 30 H.P. For Sir Wm. Gray & Co.—Enclosed compound engine of improved self-lubricating type, coupled direct to "Tyne" dynamo with drum bar armature. Output, 44,000 watts. For Messrs. Walter Scott & Co., for London Central Railway.—Electric locomotive fitted with motor of 25-H.P. and suitable for 2 feet gauge; designed for mines, or for contractors' use underground. For Messrs. Humphreys, Tennant & Co.—Four sets of 20-inch centrifugal pumps and engines combined. For the St. Petersburg Cement Co.—Two 4-foot ventilating fans, with motors combined, capable of delivering 10,000 cubic feet of air per minute at 4 inches pressure.

Electrically-Driven Wood Working Machinery.—The *Timber Trades Journal* for February 19th is the twenty-fifth special anniversary issue of that journal. The number is special for several reasons. It consists altogether of over 260 pages of reading and advertisement matter, and the number of special articles got together for the occasion must have entailed an immense amount of work. Our attention is especially drawn to the engineering section, where among other matter we observe a lengthy article on "Wood Working Machinery with direct Electric Driving," in which are shown planer, saw bench, band-saw, boring, and other wood-working tools with electric motors attached. The machines were made and fitted by Messrs. Kirchner & Co., Limited, 118, Queen Victoria Street, E.C.

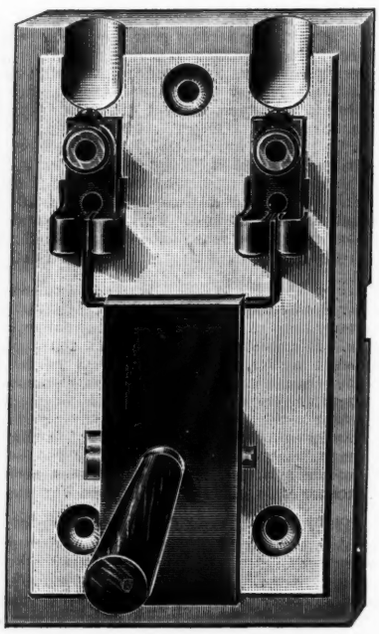
E.P.S. Batteries.—Mr. J. W. Barnard informs us that his engagement as secretary of Electrical Power Storage Company, Limited, having terminated, the company have appointed him their sole agent in the United Kingdom for the sale of their Q and V types of storage cells. It will be remembered that these types of E.P.S. cells are intended specially for use in connection with carriage, cycle, miners', domestic hand-lamps, phonographs, electro-medical appliances, &c. Mr. Barnard has secured offices at 4, Great Winchester Street, E.C., where he will have every opportunity of meeting the numerous customers of the Electrical Power Storage Company who are interested in this particular branch of its manufactures.

Forthcoming Books.—Messrs. Whittaker will publish immediately "Alternate Currents in Practice," translated from the French of Loppe and Bouquet, by F. J. Moffett, A.I.E.E., electrical engineer to the colony of Lagos, W. Africa. "Electrolytic Methods of Analysis," translated and adapted from the German of Dr. B. Neuman, by J. B. C. Kershaw, F.I.C., and a volume on "Radio-

graphy," by S. Bottone, a well-known writer for amateurs upon kindred subjects. The same publishers will also issue, in conjunction with the General Electric Company, "A Popular Guide to Commercial Telephony," by M. Byng, M.I.E.E., and F. G. Bell.

Flannery v. The National Telephone Company, Limited.—In the Queen's Bench Division, before the Lord Chief Justice and a special jury, Mr. J. Fortescue Flannery, M.P. (of Flannery, Baggallay & Johnson), sued the National Telephone Company for damages for breach of contract in failing to supply his house at Norwood with a telephone connection within reasonable time according to the terms of an agreement entered into between the parties. It appeared that in 1893 Mr. Flannery was proposing to stand for Parliament, and in order to be able to attend to his business, which he carried on in the City, as well as to matters connected with his Parliamentary candidature, he thought it would be convenient to have a telephone at his house at Norwood. He therefore communicated with the company, and entered into a contract for connecting his house with an exchange on March 8th, 1893. As there was considerable delay about the matter he complained to the company, and they said that the reason of their delay was that they could not get wayleaves by the route they were proposing to adopt through Streatham. Eventually at the end of May, 1896, the plaintiff's house was connected with the Sydenham exchange. Mr. Flannery said he had been put to great inconvenience by this unreasonable delay, and he brought this action in the interests of the public. The defendants counterclaimed £25 as rental due since the house had been connected, and the plaintiff admitted his liability, and paid the amount into Court. His Lordship asked the jury to consider whether the defendants had taken reasonable and proper steps to carry out their contract, or whether they had been guilty of unreasonable delay. The jury found there had been unreasonable delay on the part of the defendants, and gave a verdict for the plaintiff for £5. Judgment was accordingly given for that amount for the plaintiff on the claim. Judgment was also entered for him on the counterclaim, the defendants to have costs up to the date of payment into Court, and all costs to be on the High Court scale as the case raised an important question.

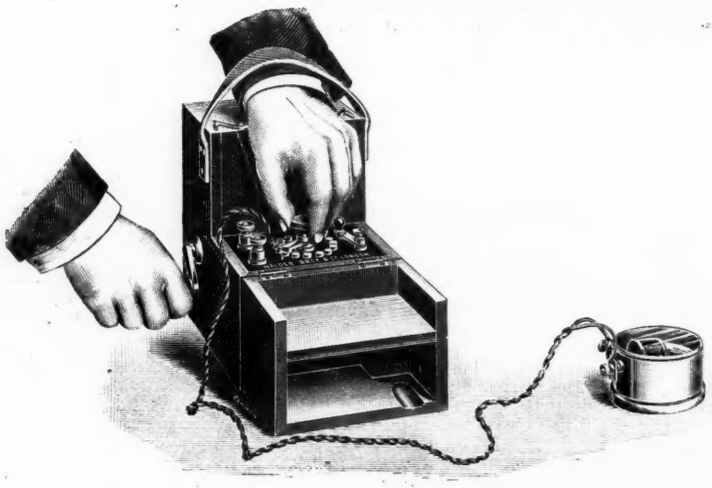
High Voltage Main Switch.—The switch we illustrate below has been designed by Messrs. W. T. Burbey & Co., of Hatton Garden, to meet the requirements of the various central stations and insurance offices for 200-volt supply. In the case of double and triple pole switches, each pole is protected by a



separate china cover, which is fixed by means of a strap and seal on the outside of the switch. The cable connectors are on the front of the switch, as preferred by station engineers, but if a back connection is required, the base is so made that they could be allowed for without extra charge. Front cable connectors are always supplied, however, unless otherwise ordered.

List.—Messrs. Measures Bros., Limited, send us a pocket list, with calendar, giving particulars of their stock sections of steel joists, rails, plates, &c. Numerous tabulated figures are given, showing the breaking loads of cast-iron columns, weights of various sizes of metals, weight per foot of different metals, and other useful notes of a similar kind.

N.C.S. Insulation Test Set and Generator.—We illustrate below the latest pattern of N.C.S. insulation test set. It consists of a 200-volt generator in one case, with Messrs. Nalder Bros. and Co.'s well-known insulation test set. It gives a plain bridge measurement of the insulation under test, thus obviating all errors due to change of magnetism of the needle, or to disturbances from any magnetic bodies in the neighbourhood. The readings depend solely



on carefully wound coils, just as in an ordinary bridge. It reads direct, without calculation, from ·1 megohm up to 50 megohms, with 20 intermediate values. A perfectly sharp difference is obtained between 50 megohms and infinity, and all the other readings are equally sharp. By pushing over a small switch, the readings are all divided by 10; that is, the bridge then reads from ·01 megohm (or 10,000 ohms) up to 5 megohms.

Leicester Corporation v. Warren Hill.—A case of considerable importance to electrical engineers, came on for hearing at the Leicester County Court, on the 24th ult., before his Honour, Judge Wightman Wood, in which the Mayor and Corporation of Leicester, sued H. Warren Hill, electrician, of King Street, Leicester, to recover the sum of £4 19s., in respect of goods sold and delivered. Mr. Simpson, on behalf of the Corporation, stated that so far as the actual purchase was concerned, there was no dispute. The defendant purchased a number of appliances on September 15th, 1895, from the electrical department of the Corporation, but declined to pay for them, on the ground that the Corporation were trading *ultra vires*. There were altogether eight items in the purchase, and in respect of the the first item, 10s. 6d. had been paid into court. The point at issue was whether the Corporation were entitled to sell and recover the price of articles and apparatus, used in connection with the supply of electricity. Mr. Simpson proceeded to quote clauses in the various Acts of Parliament, under which the Corporation supplied electricity, and maintained that they could also deal in apparatus and appliances. Mr. Newell for the defence, said it was a public corporation, and held delegated powers to supply electricity to the public, but it has deviated from those powers, and was selling lamps and appliances, which were not necessarily connected with the supply of electrical energy. They had become traders and shopkeepers, and thereby damaged the local tradesmen, with whom they were unfairly competing. The Corporation, in fact, competed with the local shop-keepers by means of the very rates which the tradesmen partially contributed. His Honour: I suppose this is a case brought on principle? Mr. Newell: Yes, the defendant does not by any means wish to shirk the liability. His Honour: Do you mean to say that under the Charter of Elizabeth, the Corporation has no power to trade. Mr. Newell: I should say that such is the case. Eventually his Honour said he should take time to consider his judgment, as there were important issues raised. Mr. Newell said if his Honour was against him, he should have to appeal, as the Corporation had taken away the bulk of the electrical trade in the town.

Liquidation Notices.—At a meeting of the Crompton-Howell Electrical Storage Company, Limited, held at Mansion House Buildings on January 24th, a resolution was passed winding up the company voluntarily, and appointing Mr. R. H. Marsh, of Ethelburga House, Bishopsgate Street, E.C., liquidator.

A New and Novel Telephone.—Messrs. Henderson, Bunn & Co., Limited, of 15 and 16, Giltspur Street, London, E.C., are introducing a telephone, which will be of interest to many of our readers. It is, perhaps, the smallest and most compact instrument yet produced; at any rate, the patentees claim it to be so. A microphone transmitter and a bell push are fitted into a case, which, when the instrument is not being used to receive or transmit a message, is connected with the receiver in such a way that the two together form a pear shape, quite dust and moisture tight. The receiver is so

contrived, that when the transmitter is slipped upon it, a metal nib is pressed, which actuates a Morse key in such a way that the circuits are changed from the microphone and receiver to the bell. When the bell has been rung, the two parts are separated, which act puts the receiver and transmitter into circuit. A braided flexible cord, containing the wires, join up the instruments in such a way, that the receiver may be held to the ear, and the transmitter before the mouth. The internal mechanism is extremely simple, and cannot get out of order and prove ineffective unless the instrument be tampered with. The bell push is likewise upon the Morse principle. Every contact piece is made of platinum; the screws are of brass; the coils cased in, and especial care is given to secure perfect insulation. The ordinary type of instrument is suitable for distances up to 500 yards; beyond this distance an induction coil is used. The induction coil is buried in the rose which carries the bell. The size of the pear over all is 3 inches × 2 inches. Of course, any number of ways may be allowed for, and by means of a line selector, any one of a number of stations may be communicated with. The telephone has been designed with a view to satisfying those who require a portable telephone, small and compact. Each telephone is supplied with about 4 feet of flexible cord. The cases of the instrument are made of vulcanite, with silver plated mounts, the whole presenting a handsome and highly finished appearance.

New Company.—A company has just been registered in Brussels with the title La Compagnie d'Electricité Thomson-Houston de la Mediteranée.

Omnibuses.—In his remarks to the shareholders of the London General Omnibus Company last week, the chairman said that the directors were watching very closely the development of motor vehicles, but as the prime cost of a motor 'bus would not be less than £500 to £600, they did not see their way at present to adopt them. It is interesting to note that the company values its horses at £27 a-piece. Many of them cost between £30 and £50.

Outlet Boxes.—The Ward Leonard Electric Company, of Bronxville, New York, send us a copy of their new catalogue of outlet boxes. We understand that these porcelain-lined boxes have become standard for good wiring work in New York City, and is becoming so in other large cities. The list shows that 81,000 were installed in New York City alone in 1897. The company make outlet boxes of every variety, including a large number of "specials" not shown in the list. Prices and particulars are given.

Presentation.—On 28th ult., a handsome gold watch, with an illuminated address on vellum, was presented to Mr. T. W. Vaughan on his 50th birthday, managing director of Vaughan and Brown, Limited, of Kirby Street, Hatton Garden, and Great Saffron Hill. The presentation was made by members of the staff and old employés, some of whom have been with the firm from 20 to 35 years.

"Specification."—This is the title of a new publication, to appear, revised and enlarged, quarterly. The volume (over 300 pages) is intended for architects, surveyors, and engineers when specifying, and for all interested in building. It is divided into three sections, *i.e.*, construction, professional practice, and buildings in progress. There are some general notes on electric lighting, arc and incandescent, giving particulars of the points to be considered in laying out an installation, and a glossary of English, Irish, and Scotch electro-technical terms is included. There are similar details *re* electric bell work. The price of the publication is 2s. 6d., and it is issued from the office of the *Builder's Journal*, Effingham House, Arundel Street, W.

Westminster Engineering Company v. Kent.—This case came before his Honour Judge Lumley Smith, Q.C., in the Westminster County Court on Friday last. The point in dispute was whether the trade discount should be 10 per cent. or 15 per cent., and whether there should be a cash discount of 2½ per cent. Plaintiffs said their terms in all these cases was 10 per cent., and cash discount was only allowed in some instances, and then only if cash was paid within a month. There was no discount on the wiring, and no special terms were made, and 2½ per cent. was not allowed on estimated work. Mr. Geo. Kent said the question was entirely one of principle. He was a builder, and where he got instructions to fit with electric light, the work was handed over to the plaintiffs for the wiring and fitting, and they always received 15 per cent. on the work done. This had been the custom for many years, and only on three occasions was that departed from, and there were exceptional circumstances in each case. The 2½ per cent. for cash was the custom of the trade. His Honour said he thought the plaintiff was right with reference to the cash discount, and gave judgment for £6 5s. 10d. With regard to the other defendant was right.

Willing's Press Guide.—The 1898 issue (twenty-fifth annual) of this book is before us. It is published by Messrs. Willing, at 125, Strand, (1s.) and contains in easy reference form details of newspapers published at home and abroad, giving the first year of publication, &c. The London addresses of provincial, colonial, and foreign papers are also given.

W. T. Burbey & Co.—With reference to our notice of the dissolution of the partnership of Messrs. Burbey & Hutton, we are asked to state that the business will be carried on under the style of W. T. Burbey & Co. The firm has issued a new catalogue, a copy of which is before us. In it are described and illustrated distributing switch and fuse boards, accumulator plant board, accumulator switches, main switches of various types, cut-outs, tumler switches, &c.

ELECTRIC LIGHTING NOTES.

Aberdeen.—There was a recommendation of the Lodging House Committee before the Town Council, last week, to accept the tender of Messrs. P. C. Middleton & Co. (£177 odd), for electric wiring of the Corporation lodging house, but the matter was referred back.

The question of reducing the charges for current has been before the Electric Lighting Committee lately, but as the new system of charging has only been in operation for six months, no change is to be made during this half-year.

Bangor.—A Local Government Board inquiry was held on 25th ult. regarding applications *re* various loans, including a sum of £450 for the purchase of an electric light station site.

Barnet.—An electrical firm has offered to take over the District Council's electric lighting order. A committee is considering the matter.

Bath.—The state of the new electricity station was under consideration at last week's meeting of the Electricity Committee. The causes of the various delays were stated, but it was impossible to say when the buildings and the whole of the plant could be ready. Mr. Robert Hammond gave details of the forward condition of some of the machinery and the completion of part.

Bedford.—The Town Council is to purchase two more mechanical stokers at an estimated cost of £385, also two water purifiers in connection with the steam boilers at the price of £120. The electrical engineer is to consider and report as to the practicability and cost of (*a*) installing an electric motor at the water pumping works in place of present boilers now consuming coal, value £500 per annum; (*b*) letting out on hire motors for power, heating and cooking apparatus, with current at 2½d. per unit for certain day hours; (*c*) introduction of prepayment slot meters and wiring houses upon agreement; (*d*) the desirability of applying for powers to construct and work a service of municipal electric self-contained accumulator passenger cars connecting various parts of the town at fares of 1d. At the last Council meeting it was reported that a motor was being installed. Clauses (*b*) and (*c*) were carried, as was (*d*) after discussion.

Consumers were to hold a meeting yesterday to consider the high charges for current.

Belfast.—A sub-committee has been appointed to report on the question of the supply of current for power purposes.

Bradford.—A sub-committee has been appointed to consider the desirability of reducing the price of electricity for lighting purposes. The present charge is 5d. per unit.

Brewery Lighting.—The brewery and business offices of Messrs. George Younger & Sons, Limited, at Candleriggs, are now lighted by electricity. It is stated that the Alloa local authorities have decided to light the principal streets in the same way next winter—cost, £3,000.

Bridlington.—The Council, in reply to a letter from a Sheffield firm, says that it intends applying for an electric lighting order on its own account.

Brisbane.—Mr. Hesketh, electrical engineer to the Queensland Government, in reporting on the proposed electric lighting of Brisbane, states that at first operations should be confined to the main streets of the city, using the direct-current system, with a three-wire distribution at 400 volts.

Buxton.—Prof. Kennedy's report on electric lighting was before the District Council last week. He estimates the cost at £18,000, and recommends a site near the gas works. The Council will hold a special meeting this month to discuss the matter.

Camberwell.—At the last Vestry meeting the General Purposes Committee recommended that notice be given to the County of London and Brush Provincial Electric Lighting Company requiring them to sell their undertaking to the Vestry. The terms were stated to be £133 for every sum of £100 properly expended by the company, and 5 per cent. per annum dividend. After some discussion the recommendation was referred back to the Committee.

Carlisle.—The Carlisle Citadel Station Joint Committee have decided to have the station lighted by electricity. The necessary dynamos and apparatus have been ordered, and the work will be begun at once by the London and North-Western Railway electrical department.

Chelsea.—The Vestry is considering the advisability of purchasing the undertaking of the Chelsea Electricity Supply Company, Limited, forthwith. A committee has power to consult experts.

Coventry.—The annual report of the Electric Light Department shows that the number of consumers increased during the year 1897 from 72 to 100, and the lamps connected from 5,662 (8 C.P.) to 8,149. Further connections are being made. The number of units sold had increased from 51,114 to 79,583, and the revenue from current and meter rental from £1,245 16s. 6d. to £1,958 19s. 8d. The profit on working was £106 2s. 8½d., as against a loss the previous year of £41 0s. 8d. The net charge on the rates was £1,558 7s. 11½d. as compared with £1,706 13s. 8d. the previous year.

Dublin.—The Electric Light Committee is reported to have decided to advertise for tenders in connection with the laying of the new cables for the electric lighting of the city.

Edinburgh.—The Council has accepted the offer of Messrs. Wm. Clowes & Sons, Limited, to purchase two engines and dynamos now at the Torphichen Street station for £1,100. These are too small for the Corporation station, and Prof. Kennedy advised the acceptance of an offer. Electric light is to be introduced into the Police Chambers at an estimated cost of £640. A new feeder is to be laid from Dewar Place, along Grove Street, and out to Marchiston at a cost of £1,400.

Edmonton.—The Board of Guardians have referred the matter of electrically lighting the workhouse back to the architect, Mr. Knightley, to obtain plans, specifications, and estimates.

Exeter.—Twelve more electric meters are to be obtained. The clerk is informing the contractors for the electric street lamps that unless they are supplied forthwith in accordance with the contract proceedings will be taken. In consideration of the extra work which has devolved upon the assistants and clerk, £30 additional remuneration has been voted for them. A complete return giving the results of 18 months' working, to the end of 1897, shows a gross profit of £1,843. Of this £1,018 goes for interest and sinking fund, £750 is put aside for reserve and £75 is carried forward.

Greenock.—Mr. Teague, in his report as to the electric lighting of Greenock, states that the most suitable site for the installation would be at the Water Trust works at Prospect Hill, and the cost (apart from site) of laying the necessary plant to light the streets from Rue-End Street and along west to Campbell Street, would be probably about £25,000. Mr. Teague will submit a complete report. He recommends a modified scheme, and advises the Board to take up the matter themselves.

Harrow.—Mr. Hawtayne, engineer to the Electric Light Company, recently submitted plans for the extension of the mains down Southill Avenue.

Hartlepool.—The Guardians have decided to obtain a report in reference to the suggestion to light the workhouse by electricity.

Hampstead.—The Vestry Clerk has been instructed to communicate with Messrs. Ferranti, informing them that if the new plant ordered is not immediately made available for the purposes of the station, as provided for in their contract with the Vestry, the Vestry will put in force, without further notice, their powers under the contract.

Hoarcross.—An electric light installation has just been completed at Hoarcross Hall and Church for the Hon. Mrs. Meynell Ingram. Messrs. Walker Brothers, of Birmingham, carried out the work.

Hull.—At a meeting of the Electric Light Committee last week the electrical engineer (Mr. Barnard) reported, with respect to the price of current for motive power, that he had been approached by several gentlemen who were considering the question of using the Corporation supply, as to the price charged for current for electric motors. It appeared that the present price of 4d. per unit did not compare favourably with the price charged in Hull for gas for gas engines. He had gone into the question and was of opinion that the price at present charged, namely 4d. per unit, might be very substantially reduced. During 1897, the number of units sold for purposes other than lighting was only 2,550. It was resolved that from March 31st next, the price for current for purposes other than lighting be reduced to 2½d. per unit.

Ipswich.—The Electric Lighting Committee is inviting offers from firms willing to carry out its electric lighting order.

Lancaster.—The Council will borrow £10,000 to increase the plant in the electricity department, so as to double the output.

Leeds.—The Parliamentary Committee has decided to recommend the City Council to formally make a definite offer to the Yorkshire House-to-House Electricity Company for their undertaking.

Lewisham.—The Board of Works has resolved not to give its sanction to the proposed scheme of the Great Western Electric Light and Power Company.

London.—The Local Government Board has sanctioned the proposal of the Metropolitan Asylums Board to enter into a contract with Messrs. Crompton & Co., for two dynamos for the *Exmouth*, at a cost of £105 without first advertising for tenders.

The Metropolitan Asylums Board has appointed Messrs. Burstall and Monkhouse, engineers for the electric light installation at the Northern Hospital at a 5 per cent. commission.

The wiring of the new offices of the Court of Common Council Public Health Department is in progress, and the court-room of the late Commission of Sewers and the offices of the engineer are also to be fitted at a cost of £120.

London County Council.—The contract for the electric lighting installation for the Metropolitan Fire Brigade headquarters has been given to the National Free Wiring Company, Limited. The work comprises steam dynamo, storage batteries, incandescent and arc lighting complete. The same firm have also secured the order for the installation of the electric light at the Bridge Hotel, Arundel. The National patent system of house wiring is to be used throughout in both these cases.

Loughboro'.—A committee has been appointed to report on the advisability of taking steps to acquire the gas undertaking, and also to obtain information and report on the question of electric lighting.

Manchester.—Arrangements have been made by the Manchester Corporation with the Moss Side and Levenshulme District Council, by which those districts shall be supplied with electric light at the rate charged to Manchester consumers.

Morecambe.—Mr. Parkinson was recently authorised to instal electric light in the central generating station and the sub-stations.

Portsmouth.—In respect of the proposal to erect a refuse destructor at the electric lighting station, Alderman G. Ellis has reported that there is no land available for the purpose; the boilers at the station could not be used in connection with destructors, and the chimney is not the proper shape. In fact, at present it is altogether impossible to use a destructor at the station. When a new engine house and engines were provided the advisability of building a destructor might be considered.

Sheffield.—The City Council had a brief discussion last week regarding the purchase of the electric light company's undertaking, and in consequence the negotiations will now be completed. It will be remembered they were brought to a standstill by the company objecting to certain statements and insinuations recently made in the Council. In connection with the purchase arrangements Mr. Joshua Wortley, chartered accountant, has examined and reported upon the company's books, and he gives the following note of capital expenditure to December 31st, 1897:—

Capital Expenditure to December 31st, 1897.

			£	s.	d.
Electricity Department—					
Land		12,253	9	8	
Buildings		14,410	14	9	
Machinery and Plant		35,981	7	2	
Mains (New Account)	£36,193 12 0				
Mains (Old Account)	1,908 3 1				
Mains (Service)	2,829 15 8				
Mains (Instruments)	23 0 4				
		40 873	11	1	
Transformers, Motors, &c.		6,462	12	6	
Meters		4,001	16	0	
Electrical Instruments		617	16	1	
Cost of License		334	10	1	
Office Furniture		278	6	6½	
Tools		121	17	8	
Formation Expenses		200	3	0	
Depreciation written back—1892	£153 15 9				
Depreciation written back—1894	202 7 2½				
Depreciation written back—1895	220 16 11				
Depreciation written back—1896	445 9 0				
		1,022	8	10½	
Library		44	11	11	
New Office Account		110	1	2	
Construction Stock		1,699	2	6	
		£118,418	8	2	
Wiring and Fittings Department—					
Tools	£68 16 6				
Depreciation written back	19 11 7				
	£88 8 1				
Showroom	212 4 7				
Depreciation written back	115 17 10				
	328 2 5				
		416 10	6		
Factory—					
Plant and Tools	£1,516 10 1				
Buildings	2,655 12 10				
Office Furniture	66 3 3				
Patterns and Models	353 18 0				
Catalogues	626 1 6				
Formation Expenses	729 3 1				
		5,637	8	9	
		£124,472	7	5	

As recently stated, the company receives £213 8s. for every £100 share originally invested, and in addition £70,000 for stock and stores in hand and recent capital expenditure.

Southampton.—The Sub-electric Lighting Committee reported that the output for December and January showed an increase of 38 per cent. and 36 per cent. respectively over the corresponding periods of last year. At a recent County Council meeting Mr. Manville read a report on low tension mains to be laid in connection with the high tension system outside the centre of the town. In view of the probability of the house connections becoming numerous in many streets, and also of the advisability of making a supply in further streets or roads adjoining those already decided upon, he suggested that it would be advisable to lay low tension mains at once from which to supply consumers, and place large transformers in street boxes, feeding into these low tension mains in place of small isolated ones on the premises themselves. He had conferred with Mr. Lee, and they had picked out those streets which are likely to prove the more remunerative in the immediate future, and in these streets and roads he proposed that a low tension concentric main should be laid. In addition to these streets and roads he would propose that a low tension main be drawn into the ducts already laid to carry the high tension feeder and the tramway feeder, with one spare duct in the other stated streets. The total cost would be £3,500. The Electric Lighting Committee recommended the Corporation to lay additional mains in various streets, &c., at a cost of £4,000, and to apply to the Local Government Board for sanction to borrow the amount; also that application be made to borrow the amount required for various works already sanctioned by the Council, and in addition to the sum of £54,000 previously sanctioned by the Local Government Board. As to public lighting, Mr. Manville reported that the position for the arc lamps should be largely guided by the necessary position for the standards carrying the trolley wire for the tramways. He suggested that he should be given power to lay out the position of the new tramway lines, in order to be able to fix the position of the standards carrying the trolley wire, which

could then be ordered, together with the requisite materials for the public lighting. Mr. Manville was instructed to submit report and plans upon the proposed position of the standards, to carry both the trolley wire for the tramways and the arc lamps for public lighting along the route of tramways. He reported that the first alternator will be delivered and set to work by May 30th, the second by June 16th, and the third by July 7th. The motor-alternator on June 6th, and the two new continuous current dynamos on July 5th and 26th respectively. As to the high tension switchboard, the Committee recommended the Council to procure a high tension switchboard from Messrs. Ferranti, at an additional cost of £314 (£714 in all), and apply to the Local Government Board for sanction to borrow this amount. They also recommended that the tender of Messrs. Pritchetts & Gold be accepted in substitution for the tender of the Chloride Electrical Storage Syndicate, Limited, for accumulators. For the supply of from 150 to 200 tons of large steam coal the tender has been accepted of Messrs. E. T. Agius & Co., at 16s. 9d. per ton. The committee instructed Mr. Manville to submit a report and plans. The committee's report was adopted by the Council.

Southborough.—The District Council will oppose the application of Mr. D. E. McKrell, of Little Mowhurst, Edenbridge, for a provisional order.

Stirling.—Prof. Kennedy has submitted a further report to the Town Council *re* the water power at Touch in connection with proposed electric lighting. He finds the maximum theoretical hydraulic H.P. coming into Stirling at 40. The actual amount of this H.P. in the mains for supplying light would not be more than half this. The total H.P. provided for in Prof. Kennedy's steam-power estimate was 320, which would deliver at least 233 electrical H.P. at the lamps. The total cost of this plant would be between £8,000 and £8,500. If turbines and dynamos were put down at Touch, at least £1,600 would have to be spent, and probably considerably more, to deliver about 15 H.P. at the lamps. The capital expenditure on this power would, therefore, be about £107 per H.P. at the lamps, as against about £35 for the steam plant.

Sunderland.—The Lighting Committee has presented a report on electric lighting extensions. Mr. Snell, the electrical engineer, says that further extensions are necessitated by the increased demand. Looking ahead, he estimates that to meet the requirements up to 1901, £12,728 would be required for buildings, boilers, and dynamos, tools, &c., and a further £12,540 for mains and such like. Immediate requirements would be met by £7,800. Application to the Local Government Board for leave to borrow not less than £25,000 is suggested. With this sum it is thought that all the districts in the borough can be served. Mr. Snell estimates that in the first year the profits would be £105, in the second, £760, and in 1901, £1,370.

Swansea.—The Sub-Electric Lighting Committee had a conference with Mr. Manville on Saturday *re* electric lighting. Mr. Manville recommended low tension for the present scheme, and will at once prepare a report. There was practical unanimity as to proceeding with the scheme immediately. The question of a dust destructor was discussed.

Swinton.—Mr. Scott Anderson is to advise the Urban Council on the matter of electric lighting.

Trinidad.—A Liverpool paper says Mr. J. Stanley Richmond, who has had a good deal of experience with English and American houses, has secured the appointment of electrical engineer to the Government of Trinidad to examine and report upon the various systems—light, power and telephone—using electric currents in Port of Spain and its vicinity, with a view to determining the risk to life and property now involved.

Wakefield.—On Tuesday last week the New Municipal Buildings for the County Council of the West Riding of Yorkshire, were opened. These premises, which have cost about £130,000, have been fitted up for the electric light by Mr. T. Harding Churton, of Leeds; there are in all about 1,100 lights, all the wiring being carried out in insulated conduit, the distribution being effected by the switch and fuseboard plan. All the electroliers have been specially designed by the architects, and are of a most artistic character. The light was on for the opening and gave great satisfaction. The buildings are fitted throughout with a complete telephone installation. There are five exchanges in the building, all being connected by "up" and "down" trunk lines. All the wires, which have been run in iron conduit, are metallic circuit. This work has been carried out by the Private Wire and Telephone Installation Company. All the electrical work has been under the direction of Mr. Sidney A Court, A.M.I.C.E., of Victoria Street, S.W.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Ashton.—The Council will oppose the Bill of the Manchester Carriage Company on various grounds, one being that it is calculated to prejudice the Corporation's power to purchase the tramways three years hence. The Corporation already has electric lighting powers, and, therefore, objects to the company having similar powers.

Bordeaux.—The report of the Bordeaux Tramways and Omnibus Company for the year 1897, says that the question of electrical traction has received constant attention from the directors during the past year, and after lengthy negotiations they succeeded in coming to terms with a committee of the Bordeaux Municipal Council appointed for the purpose. Since the end of the year, however, the Council has rejected the committee's report by 18 votes to 15. The directors, whilst regretting this decision, feel that they have gone as far as they prudently can in their endeavour to meet the views of the municipality without prejudicing the position and interests of the shareholders.

Bournemouth.—The electric tramway schemes which were being promoted here will now fall through. The Light Railway Commissioners have held a lengthy inquiry at Bournemouth with respect to applications by two electric tramway companies to construct lines connecting Bournemouth with Poole and Christchurch. Strenuous opposition was offered by Bournemouth Town Council to any tramways being laid within the borough. The Commissioners, over whom the Earl of Jersey presided, decided that no public necessity had been proved to induce them to overrule the decision of the Council or to authorise any remaining portions of the two schemes which lay outside the borough.

Brighton.—The Bill for the construction of an underground electric railway from the Brighton terminus to the sea front passed the second reading in the House of Lords last week.

Bristol.—Controversy between the Bristol Tramway Company may still be regarded as acute, but citizens have an impression that possibilities of a settlement are nearer. In a speech to the company's shareholders the Chairman of the company criticised the assumption of the Sanitary Committee as to the extent of the saving which electricity made possible in working expenses, and declared as the result of their experience the working expenses of electric traction cannot be reduced below 60 per cent. of the receipts. These figures were important, bearing in mind the allegation of the Sanitary Committee that electric power would enable the company to reduce fares and to pay a royalty to the Corporation. The civic electrical engineer, Mr. Faraday Proctor, included this subject in the report in which he embodied information derived from his visit to Liverpool, Manchester, Bradford, Leeds, and Sheffield. He took, as the result of figures he has supplied to the committee in reports which have not been made public, 4½d. per car mile as the total cost of working trams in Bristol should electricity be applied. That this amount was ample was, he said, shown by figures of other towns. When the Bristol company had one line working by electricity they stated that the cost was found to be 5½d. per car mile, as compared with 9½d. for horse cars, and in this case plant was "admittedly badly arranged." Thus, according to the company's own showing, the cost was only 41·67 per cent. of the electric car receipts. In a supplemental note the engineer again referred to the plant, and termed it "an absurd arrangement of engines and dynamos coupled together by ropes for driving purposes." Better engines than those in question did not exist when they were properly used, but the Tramway Company threw out the whole plant, and put in fresh. A great expense had been incurred, and it ought to have been, and doubtless was, charged to revenue. This, he suggested, might have raised the cost of working, and he asked suggestively if the cost of the advertising, circularising and printing on behalf of the company during the controversy (the propaganda has been very extensive) has not also been charged to revenue, so as to raise the working cost. Basing a calculation on the 4½d. per car mile for electric traction, as compared with 9½d. for horse cars, Mr. Faraday Proctor pointed out that on the mileage for the year ended June 30th, 1897, the company would make an additional profit of £36,380 by the adoption of electricity. This would be altogether apart from the probable increase of traffic. The secretary to the company, Mr. Sam White, in reply denied that the company ever stated that they found the cost of electric traction 5½d. per car mile as against 9½d. for horse traction. "This assertion is absolutely untrue," said the company's representative, "no such statement has ever been made, and the two figures named are incorrect." He challenged the Electrical Engineer to name any place in the Kingdom which justifies the statement that 4½d. per car mile for electric traction can be taken as the total cost. The Engineer's estimate of the cost of the trolley system meant that working expenses would be only 35·29 per cent. of the receipts, a ratio unheard of amongst tramway men for the operation of any tramway in the world. Mr. White then alluded to the information given by Mr. Faraday Proctor with regard to the working in northern cities, and said its "fragmentary and unreliable character is perhaps excusable, seeing that he himself tells us that having received the Committee's instructions on Monday he was able to visit Liverpool, Manchester, Bradford, Leeds and Sheffield, and return to Bristol in time to prepare his report on the subsequent Friday," Mr. White concludes his letter by stating that he considered it undesirable to reply upon the general tone of this report, or the "offensive innuendos as to the company's management." The Tramway Company has also replied to the Corporation upon the terms submitted and reported in last week's Electrical Review. The company do not consider the Corporation justified in seeking to impose conditions as to the terms of employment of the tramway men, and give figures to show the Bristol men are well treated already. The company see no objection to the tramways to be worked electrically being specified in the Bill; they agree to the Corporation control over streets and works being as under the Act of 1894; they agree that the company shall not supply electricity to others, or that the company shall not require the Corporation to supply them with electricity. They agree also that the company's posts shall be usable by the Corporation for electric lighting standards, although they regard this as equivalent to a gift to the city of £10,000. They contend that the purchase of lines by the Corporation must be coupled with purchase of the company's power station, as the two cannot be severed, and when the purchase takes

place the company will arrange for working any tramways outside the city which may have been operated from that power station. The company do not seek to disturb the existing periods for the purchase of the west horse lines by the Corporation, but drafted the Bill on those lines, not contemplating the Corporation imposing additional and exceptional obligations on the company, and if such obligations are imposed they could only be undertaken if accompanied by an agreed extension of the purchase period. The company do not propose to proceed with their extensions Bill unless under the terms of 21 years' purchase contained in the Tramway Act. The company refuse to consent to the issue of new capital by auction, but are prepared to discuss the payment of an annual sum to the Corporation and the reduction of fares, if an arrangement is arrived at for fixing the period of purchase of all the company's tramways within the city of Bristol at one uniform date—25 years.

It is reported that in the last few days a body of motor-men of the Bristol Tramway Company (said to be 25 in number) have taken part in an agitation for improved conditions of employment, and have been dismissed from their situations.

Chiswick.—A poll of this district is to be taken to ascertain the feeling in regard to the electric tramway scheme of the London United Tramways Company.

Clontarf.—The work of laying the electric cable for the Clontarf tram line to Nelson's Pillar was commenced last week by Messrs. Porte, Sykes & Co., of Dublin.

Collision.—One of the Dublin electric cars collided with a cart one day last week and did considerable damage to both conveyances, at the same time seriously injuring the car driver.

Dalkey.—The Dalkey Town Commissioners will send witnesses to support the Bill now being promoted by the Dublin and Southern Districts Tramway Company to amend the provisions of their 1893 Act, relating to the speed of cars on the company's line. The witnesses will give evidence that the residents of the townships at large consider the present speed at which the cars are allowed to travel, far too slow.

Dover.—The contractor for the permanent way of the electric tramway was fined by the Corporation £2 per day from July 16th to December 10th (£254 total), for delay in completing the contract.

Dortmund.—The Allgemeine Lokal and Strassenbahn Gesellschaft have got out the plans for a normal-gauge light electric railway to run in connection with the Dortmund street railways. The light railway will be adapted for passenger traffic, and will run from Dorstfeld by Marten to Lütgendortmund.—*Elektr-Rund.*

Edinburgh.—The Lord Provost's Committee had before them last week the report by Prof. Kennedy on the proposed conversion of the Portobello tramways. It dealt with the arguments for and against electric traction and cable traction, and, it appears, gave great consideration to the objections of the lessees to electricity. The report was delayed.

Electric Carriages in Berlin.—The *Elektrotechnische Zeitschrift* of February 24th contains an illustrated description of two types of electric carriages which are being demonstrated in the streets of Berlin. These carriages, which have been built by one of the leading cycle companies, are fitted with bicycle wheels and pneumatic tyres, which can be inflated to a pressure of 120 lbs, whilst the bodies are supported on steel tubular frames. The wheels have ball bearings, and steering is effected by means of a lever connected with the front pair of wheels. Each carriage is equipped with a motor suspended from a steel frame lying parallel with the rear axle, the latter passing through the hollow armature shaft, and being driven by differential gearing from a toothed wheel arranged on that shaft. The battery consists of 44 cells contained in four boxes, the total weight being eight cwts. It can be charged at a pressure of either 65 or 110 volts, and the connections allow of four different speeds being attained, three by altering the disposition of the battery, and one by weakening the motor field. The carriage is provided with a watt-hour meter, which indicates the condition of the battery, and the total weight complete is 16 cwts. It is possible to attain a speed of 12 miles an hour, and one charge will allow of the carriage covering a distance of 27 miles before the cells require to be re-charged. The carriages possess a pleasant appearance, having been built specially for the work.

Electric Water Vans.—The Clerkenwell Vestry recently referred to the Works Committee to report on electric watering vans, but the committee say that they are unable to report, as they cannot ascertain that there is such a van in existence.

Great Orme's Head.—The Llandudno District Council held a special meeting last week to consider steps to be taken in regard to the proposed application to Parliament by a company for an Act to construct an electric tramway from Llandudno to or near the summit of Great Orme's Head. The terms regarding purchase by the municipality were amended.

Gateshead.—The directors of the Tramway Company in their report say that, as the shareholders are aware, an agreement has been entered into between the company and the British Electric Traction Company, Limited, which was unanimously accepted at the extraordinary meeting held on December 9th last. The scheme is now under consideration by the Gateshead Corporation and the Felling Urban District Council, whose consents are necessary before the arrangement come to can be carried into effect. Under the terms of the agreement made with the British Electric Traction Company, Limited, a director of that company is to be elected an additional director of this company, and the directors propose that Mr. Emile Garcke, managing director of the British Electric Traction Company Limited, be so elected.

Light Railway.—The Beaumaris Town Council is doing everything possible to help forward the construction of the proposed light railway from Llanfair P.G. to Beaumaris.

Hagen.—The Hagener Strassenbahn Aktien Gesellschaft is about to build, in connection with the Hagen street railway terminating at Haspe, a narrow-gauge electric light railway for passenger traffic, from Haspe to Gevelsberg.

Motor Cars in the Army.—It is stated that the Royal Engineer Committee of the War Office has appointed a sub-committee of its members to consider the adaptibility of motor cars for purposes of army transport.

Manchester.—The City Council met on Wednesday to consider the recommendation of the Special Committee *re* the working of the tramways, and to consider the necessary measures to be taken for promoting a Bill to enable the Corporation and any neighbouring local authorities to make arrangements for working their tramways in conjunction with those of Manchester, the powers to include the supply of electricity by the Corporation, or by any local authority, for working tramways in the district of such local authority.

Norwich.—The Council has, on the recommendation of the Tramway Committee, laid before the Norwich Electric Tramways Company a note of its requirements respecting the roads to be traversed by the electric tramways. Some of the roads will be paved with wood and others with granite setts.

Rome.—The question of the conversion of the present tramways into electric tramways has now for some months occupied the attention of the municipal authorities, especially since the new electric lines from Piazza San Silvestro to the station and Sant Agnese, as well as that from Piazza Venezia to San Giovanni and San Paolo, have not only been extensively used, but have also paid a good return on capital. In the Municipal Council a strong opposition to the overhead conductor has gradually arisen, and there the matter rests. Accumulator traction would be the best solution of the difficulties, but all systems hitherto have failed on account of the weight of the accumulators (3,000 to 4,000 kg.), which makes it impossible to run on steep inclines or sharp curves. The Società Italiana di Elettricita of Turin put itself, therefore, in communication with the Roman tramway company, with the view of testing the invention of a colonel of engineers, named Pescetto, which professes to reduce the weight of the accumulators to one-half. Recently the official test was made. A car with the new accumulators ran from the Quartier Ludovisi to the church of Sant Agnese, in front of the Porta Pia, and back, and took all the curves and gradients with ease. The officials of the tramway company celebrated in a suitable manner this remarkable success of an Italian invention, on Italian soil, and supported by Italian capital.—*Elektr-Rund.*

The Life of a Tramway Wheel.—At a Board of Trade inquiry, held on 24th ult., into the recent tram accident on the Sparkbrook route, Birmingham, when a car overturned, it transpired that the cause of the accident was a broken wheel of the back bogey, which brought about derailment. The particular wheel which was broken, was, according to the company's engineer, attached to the car last September. It was then 20⅛ inches in diameter. When taken from the car after the accident it measured only 19 inches in one direction, and 18⅛ inches in another. The flattening was attributed to skidding when the brake was put on. The inspector (Col. Yorke) made close inquiries as to the quality of the wheel. He was informed that it was one of the best-known makes—Miller's, of Edinburgh—and that it was of average hardness, although it had worn very badly. The life of a tramcar wheel, said one of the witnesses, was about ten months. They were calculated on the average to run 20,000 miles. This particular wheel had probably covered 10,640 miles, at the rate of 72 miles per day. The loss of a couple of inches in its diameter in so short a time was attributed to the great friction which the sludge had set up on the rails—friction which, according to one witness, was nearly as great as that of a grinding stone.

The Power Distribution Schemes.—In connection with one of the large power schemes to which we have several times referred, we understand that a Bill has been introduced into Parliament, under which it is proposed to incorporate a company by the name of the "General Power Distributing Company." Upon this company Parliament will be asked to confer power to erect a central generating station at Stockholme, Nottinghamshire, from which electricity will be conveyed throughout the proposed area of supply. This area is defined in the Bill to be "so much of the counties of Derby, Nottingham, Lincoln, and Yorkshire as is contained within a radius of 25 miles from the north-west corner of the Parish Church of Warsop, in Nottinghamshire," including all cities, county and other boroughs, towns, villages, urban and rural districts within that area. The share and loan capital of the company is proposed to be £1,000,000, of which £750,000 will be in £10 shares, and £250,000 will be raised on debentures. The promoters of the Bill are Sir Thomas Thompson, Bart., Mr. William McArthur, Mr. Ernest Lazarus, and Mr. Albert R. Monks, who, with six other duly qualified persons to be nominated by them, are to be the first directors of the new company.

Lincoln City Council is among the latest bodies to decide to oppose the General Power Distributing Company's scheme.

At a meeting of the Wolverhampton Town Council, on Monday, a letter was read from Mr. Addenbrooke, engineer to the Midland

Corporation for Electrical Power Distribution, Limited, asking the Town Council to reverse their decision to oppose the scheme. Ultimately a resolution was proposed to the effect that the letter be referred to the General Purposes and Lighting Committee for consideration. On being submitted to the Council, however, the resolution was rejected by 24 votes to 16.

Rotherham will oppose the General Power Distribution Company's scheme, as it is hoped to go in for municipal electric lighting shortly. Rowley Regis will support the Midland Company's scheme conditionally.

TELEGRAPH AND TELEPHONE NOTES.

Australian Telegraphs.—In the House of Commons on Tuesday Mr. Hogan asked the Secretary to the Treasury whether he was aware that telegraphic communication with Melbourne and Sydney had repeatedly been interrupted during the past five months; who was responsible for the satisfactory maintenance of the Australian trans-Continental telegraph line on which the interruptions occurred; and whether any steps could be taken by Her Majesty's Government to prevent these repeated failures of communication. Mr. Hanbury, in reply, said the interruptions mentioned in the question have occurred on both the trans-Continental lines. These are maintained by the South Australian and Western Australian colonies respectively. Her Majesty's Government is not in a position to take any steps to prevent the failures of communication, which are, it is understood, caused by storms. The cable companies have, however, put forward a scheme, in connection with the question of an alternative cable service, for taking a cable direct to a point near Adelaide, and this will no doubt be duly considered by the colonies concerned.

Bedford Telephones.—The Postmaster-General has replied to the Corporation that as the Select Committee of the House of Commons appointed to consider the matter has not yet reported, he cannot entertain the application for a municipal license.

Cable Repair.—The Great Northern Telegraph Company's steamer, *H. C. Orsted*, succeeded on Wednesday last week (says the *Buchan Observer*) in repairing the damaged Norwegian cable between Peterhead and Bergen. The damaged part was found about 35 miles from the Aberdeenshire coast. For some years past the cable has been frequently destroyed and broken, entailing a great deal of expense to the company. The belief is entertained that the damage is attributable to trawlers, who either cut or otherwise injure the cable in the course of their trawling operations.

French Telephones.—Telephonic communication is now established between Paris and several towns in the south-west, including Dax, Pau, Bayonne, Biarritz, and St Jean de Lux.

Some Causes of Delay in Australian Telegrams.—The following is an extract from an Australian paper dated January 13th.—"*Interruption of Cables.*—The Postal and Electric Telegraph Department has been advised by the Postmaster-General of South Australia that the Eastern Telegraph Company notify an interruption to one of their Mediterranean cables, and the Persian Gulf station reports the cutting of Mekran landlines. Some delay to European traffic is, therefore, likely to accrue therefrom." We also read the following in the *Sportsman* of March 2nd:—"Australian wires have been simply blocked by the cabled reports of the test games, causing delay, except to those forwarded at urgent private rates, *i e.*, 14s. per word, instead of the ordinary press rate, 2s." *Observer* adds:—"The fight between the representatives of the big cable syndicates to get first on the wire at the fall of a wicket is like the rush of war correspondents when a big battle is being fought, and one company will spend, probably, £3,000 in cables over the five test matches. Who says cricket is simply a sport?"

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1893 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Paramaribo-Cayenne ...	Jan. 27th, 1898 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Saigon-Hong Kong	Jan. 8th, 1898 ...	Feb. 28th, 1898.
Cyprus-Latakia	Feb. 10th, 1898 ...	...
Bolama-Bissao	Feb. 19th, 1898 ...	Feb. 28th, 1898.
Aden-Zanzibar	Feb. 28th, 1898 ...	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Cartagena-Barranquilla ...	July 4th, 1896 ...	...
Majunga-Tananarive ...	Feb. 28th, 1898	

The Telephone Service.—The Court of Common Council is sending a copy of the arguments and judgment in the recent action between the G.P.O. and the Commission of Sewers, to every municipality in the United Kingdom, as well as to the metropolitan vestries and boards.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belfast.—March 8th. The Corporation wants tenders for the wiring of the new police cells, Chichester Street. Electrical engineer, Mr. V. A. H. McCowen. See our "Official Notices" February 18th.

Belgium.—April 1st. The Municipal Authorities of Seraing are inviting tenders for the concession for the supply of electrical energy in the town for public and private lighting purposes during a period of 30 years. Particulars may be had from, and tenders to be sent to, the College des Bourgmestre et Echevins, Seraing, Belgium.

Berlin.—March 15th. The Municipal Traffic Deputation of the Town Council has opened a competition for the construction of several new electric tramways in that city. Exhaustive details concerning this project are contained in the *Elektrotechnische Zeitschrift* of the 13th inst., which mentions that proposals will be received by the Stadtische Verkehrsdeputation Rathhaus III, Berlin, by March 15th.

Blackpool.—March 22nd. The Corporation wants tenders for a tubular boiler, superheaters, condensers, rectifiers, boosters, transformers, lead-covered cables, arc lamps and pillars. Borough electrical engineer, Mr. R. C. Quin. See our "Official Notices" February 25th.

Bolton.—The Bolton School Board is inviting tenders for the supply of six electrical clocks. Specifications can be obtained from the Clerk to the Board (Mr. G. R. Rothwell).

Coventry.—March 8th. The Electric Light Committee wants tenders for the supply and erection of engine house, separate exciting and surface condensing plant, also pipework, switchboards and instruments for extensions of the municipal electricity works, Consulting engineer, Mr. Robert Hammond. See our "Official Notices" February 18th.

Denmark.—March 12th. Tenders are being invited for the supply of the engines, dynamos, accumulators, &c, required in connection with the new central station at Frederiksberg, near Copenhagen. Tenders to be sent to the Frederiksberg Sporveis-og Electricitets Aktieselskab, Gammel Kongerie, 140, Copenhagen V., from whom particulars may be obtained.

Derby.—March 24th. The Corporation wants tenders for the electric wiring of the Lunatic Asylum and premises at Rowditch. See our "Official Notices" this week.

Devizes.—March 21st. Tenders are wanted for the supply and delivery of two 40 kw. continuous current belt-driven dynamos for the Wilts County Asylum, Devizes. Engineers, Messrs. Massey & Allpress, 25, Queen Anne's Gate, Westminster. See our "Official Notices" this week.

Edinburgh.—The City Council is inviting tenders for a host of stores and sundry articles. Among the items are "electric lighting materials for the Powderhall destructor," and "upholding of electric light installations." Particulars, &c., from the electrical engineer, Dewar Place.

France.—March 31st. Tenders are being invited by the Municipal Authorities of Saint Chamond (Loire) for the concession for the lighting of the public streets of the town, either by gas or electricity. Particulars from, and tenders to be sent to, La Mairie de Saint Chamond (Loire).

Liverpool.—March 8th. The West Derby Board of Guardians wants tenders for supply and erection of boilers, engines, dynamos, batteries, wiring, &c., for the lighting of the Mill Road Infirmary. Consulting engineer, Mr. T. L. Miller. See our "Official Notices" February 25th for particulars.

Manchester.—March 15th. The Great Central Railway Company (M. S. & L.) want tenders for the supply of various materials and stores during 12 months ending April 30th, 1899. Among the items are asbestos packing, brass sheet and tubing, electrical materials, India-rubber, tin and zinc sheets, wire, &c. Particulars from Mr. A. W. Longden, storekeeper, at Junction Street Mills, London Road, Manchester.

Northwich.—March 5th. The Weaver Navigation Trustees are inviting tenders for the construction and erection of the necessary electric power plant for lighting and working the new swing bridges at Northwich. Current will be supplied by the Northwich Electric Supply Company. Engineer, Mr. J. A. Saner, M.I.E.E. See our "Official Notices" February 11th.

Pembroke (Ireland).—March 5th. The Lighting Committee wants tenders for the supply and erection of various plant, machinery, &c., for electric lighting. See our "Official Notices" February 18th for full particulars. Consulting engineer, Mr. Robert Hammond.

Plymouth.—March 23rd. The Corporation wants tenders for the supply of alternating current meters for the year ending March 31st, 1899. Particulars from Mr. J. H. Rider, Borough electrical engineer, East Street, Plymouth.

Roumania.—March 15th. Tenders are being invited by the General Direction of the Roumanian Post and Telegraphs in Bucharest for the supply of 56,000 metres of galvanised iron and steel wire.

Shoreditch.—March 8th. The Vestry wants tenders for the supply of electric cables and sundries, also engineers' tools, ironmongery, &c. See our "Official Notices" February 18th.

Southampton.—March 7th. The Corporation invites tenders for the supply of stores and fittings required in the electric light department during a period of 12 months. Tenders to the Town Clerk.

Southgate.—March 14th. The District Council want tenders for an installation of electrical communication for fire brigade purposes. Surveyor, Mr. C. G. Lawson. See our "Official Notices" this week.

Switzerland.—April 30th. The Government Authorities of Fribourg (Switzerland) are inviting plans and estimate for a projected electricity generating station of about 6,000 H.P. capacity to be established at Hauterive, where water power is available. A premium of 3,000 francs (£120) will be awarded to the three best schemes sent in. Particulars of the competition may be had from the Departement des Travaux Publics, Fribourg, Switzerland, to whom all plans, &c., are to be sent not later than April 30th next.

The War Office.—April 27th. The Secretary of State for War is prepared to receive offers, competitive designs and specifications for the supply of portable electric search light apparatus. Particulars from the Director of Army Contracts, War Office, Pall Mall, S.W. See our "Official Notices" February 4th.

Victoria.—March 21st. The Telegraph Department of the Victorian Government Railways is inviting tenders for the supply of alternating current transformers and one main switchboard. Tenders to the Telegraph Superintendent's Office, Spencer Street, Melbourne.

Wallasey.—March 17th. The District Council wants tenders for the supply of engine, alternator, exciter, two Lancashire and one water-tube boilers, and condensing apparatus. Engineer, Mr. J. H. Crowther. See "Official Notices" February 11th.

Watford.—March 16th. The District Council wants tenders for the supply and erection of various plant for the electric lighting of the district. For details of the seven sections see our "Official Notices" February 11th. Mr. W. C. C. Hawtayne, consulting engineer.

West Ham.—March 8th. The Council invites tenders for wiring and fitting up various buildings, including the Town Hall, police court, Corporation stables, fire stables, &c. Mr. J. Steinitz borough electrical engineer. See our "Official Notices" February 18th.

CLOSED.

Gloucester.—The following is a list of tenders for the supply of plant and machinery for the municipal electricity works of the city of Gloucester. Consulting engineer, Mr. Robert Hammond. The Council accepted the tenders at its meeting on Tuesday.

SECTION A.

Boiler House Plant.—Lancashire boilers and accessories, mechanical stokers, feed pump, injector, economiser, electric motor.

Name of Firm.	Make of Boiler.	Amount of Tender.
Yates & Thom	Yates & Thom .. (accepted)	£2,409
Tinkers, Limited	Own make	2,478
E. Danks & Co. (Oldbury), Limited	E. Danks & Co. (Oldbury), Limited	2,478
India-Rubber, Gutta-Percha and Telegraph Works Company, Limited	J. Adamson & Co.	2,553
H. T. Danks, Limited	Own make	2,590
Holdsworth & Sons	"	2,665
Henry F. Joel & Co., and Thos. Potter & Sons, United, Limited	Yates & Thom	2,821
John Fraser & Son	Own make	2,910

SECTION B.

Engine House Plant.—Steam Dynamos and Accessories.

Name of Firm.	Make of Engine.	Amount of Tender.
C. A. Parsons & Co.	Parsons turbine	£4,570
India-Rubber, Gutta-Percha and Telegraph Works Company, Limited	Belliss .. .. (accepted)	5,917
Siemens Bros. & Co., Limited ..	Sisson & Co.	6,495
Easton, Anderson & Goolden, Limited	Willans	6,585
Crompton & Co., Limited ..	Sisson & Co.	6,614
Siemens Bros. & Co., Limited ..	Belliss	6,720
Electric Construction Company, Limited	"	6,753
Crompton & Co., Limited ..	Sisson & Co.	6,820
Henry Joel & Co., and Thos. Potter & Sons, United, Limited	Willans	6,882
Thos. Parker, Limited	Belliss	6,980
Laurence, Scott & Co., Limited	Willans	6,994
Electric Construction Company, Limited	"	7,035
P. R. Jackson & Co., Limited ..	Belliss	7,052
Siemens Bros. & Co., Limited ..	Willans	7,060
Crompton & Co., Limited ..	Belliss	7,402
W. Sisson & Co.	Sisson & Co.	7,415
Crompton & Co.	Willans	7,640
Brush Electrical Engineering Company, Limited	"	7,749
J. C. Howell, Limited	"	7,752

SECTION C.—*Overhead Travelling Crane.*

Bedford Engineering Co., ...	£240
India-Rubber, Gutta-Percha and Telegraph Works Company, Ltd.	262
James Spencer & Co. .. .. (accepted)	265
Marshall, Fleming & Jack	267
Humpidge, Holborow & Co., Limited	285
Carrick & Ritchie	306
Henry F. Joel & Co., and Thos. Potter & Sons, United, Limited	310
Summers & Scott	315

SECTION D.—*Switchboard and Instruments.*

James White	£1 074
Nalder Bros. & Thompson .. .. .. (alternative)	1,083
Edison & Swan United Electric Light Company, Limited ..	1,083
Crompton & Co., Limited .. .. (accepted)	1,111
Nalder Bros. & Thompson	1,120
Williamson & Joseph, Limited	1,211
P. R. Jackson & Co., Limited	1,265
Veritys, Limited	1,275
General Electric Company, Limited	1,300
Ernest F. Moy, Limited	1,318
Electric Construction Company, Limited	1,357
Henry F. Joel & Co., and Thos. Potter & Son, United, Limited ..	1,393
Siemens Bros. & Co., Limited	1,530
India-Rubber, Gutta-Percha, and Telegraph Works Company, Limited	1,555
Burbey & Hutton	1,559

SECTION E.—*Accumulators.*

Electrical Power Storage Company, Limited.. .. (accepted)	1,350
Lithanode Electric Storage Syndicate, Limited	1,384
India-Rubber Gutta-Percha and Telegraph Works Company, Limited	1,537
Pritchetts & Gold	1,576
Chloride Electrical Storage Syndicate, Limited	1,700
Epstein Electric Accumulator Company, Limited	1,803
Peto Radford, Limited	1,862
Henry F. Joel & Co., and Thos. Potter & Sons, United, Limited..	1,868
Allan & Adamson, Limited	1,943
Hill, Gifkins & Co.	2,086
Tudor Accumulator Company, Limited	2,043
D.P. Battery Company, Limited	2,119
J. C. Howell, Limited	2,247
Elieson Lamina Accumulator Company, Limited	2,508

SECTION F.—*Mains.*

Callender's Cable and Construction Company, Limited, approx. .. .. (accepted)	£13,500
British Insulated Wire Company, Limited	

Schedule prices were quoted by the following:—Western Electric Company (Fowler-Waring Cables Company, Limited), W. T. Glover & Co., W. T. Henley's Telegraph Works Company, Limited, India-Rubber, Gutta-Percha and Telegraph Works Company, Limited, Siemens Bros. & Co., Limited.

SECTION G.—*Public Lamps.*

The decision upon the tenders for this section has been deferred.

Name of Firm.	Amount of Tender.
Stewart Electrical Syndicate (Part I. only)	£ 898
Brockie-Pell Arc Lamp, Limited (Part I. only)	1,058
Phæton Electrical Company, Limited..	1,552
Taylor & Fairbrother	2,198
General Electric Company, Limited	2,205
Crompton & Co., Limited	2,222
Hill, Gifkins & Co.	2,357
W. Lucy & Co., Limited	2,488
British Insulated Wire Company, Limited	2,550
Brush Electrical Engineering Company, Limited	2,679
Siemens Bros. & Co., Limited	2,702
India-Rubber, Gutta-Percha, and Telegraph Works Company, Limited	2,717
British Blahnik Arc Light Company, Limited	2,859
Johnson & Phillips	3,144
Electric Construction Company, Limited	3,330
Drake & Gorham	3,681

SECTION H.—*Meters.*

Name of Firm.	Type of Meter.	Amount of Tender.
Chamberlain & Hookham ..	Hookham .. .. (accepted)	£1,121
S. Z. de Ferranti, Limited ..	Ferranti	1,207
India-Rubber, Gutta-Percha, and Telegraph Works Company, Limited	Hookham	1,207
General Electric Company, Limited	British Aron	1,210
James White	Kelvin	1,210
Downie & Adams	Brillie	1,439

L.C.C.—The L.C.C. has, on the recommendation of the Fire Brigade Committee, accepted the tender of the National Electric Free Wiring Company (£992) to instal the electric light at the central station, Southwark Bridge Road.

Portsmouth.—For the extension of the station in Gunwharf Road (new boiler house, chimney stack, &c.), the Electric Light Committee has accepted the tender of Mr. T. W. Quick at £4,198. The following were the only tenders received for the boilers, steam pipes, condensers, economisers, &c.:—

	£	s.	d.
Messrs. Yates & Thom	7,900	0	0
Tinkers, Limited	9,215	0	0

The lowest tender was accepted. The engineer's estimate was £8,500.

FORTHCOMING EVENTS.

1898.

Friday, March 4th, 8 p.m.—At the Westminster Palace Hotel. The Institution of Junior Engineers. Paper on "An Outline of Patent Law and Practice," by Mr. Arthur H. Stanley, Fel.C.I.P.A., Member.

At 9 p.m.—Royal Institution, Albemarle Street, W. Prof. T. E. Thorpe on "Some Recent Results of Physics—Chemical Enquiry."

Saturday, March 5th.—Latest date for Northwich and Pembroke tenders.

Tuesday, March 8th.—Latest date for Belfast, Coventry, Liverpool, Shoreditch, and West Ham tenders.

Wednesday, March 9th, at 8 p.m.—Society of Arts. Prof. J. A. Ewing on "Linde's Method of Producing Extreme Cold and Liquefying Air." Prof. Dewar will preside.

At 8 p.m.—Mr. Mervyn O'Gorman will lecture on "Trades Unions and Factory Management" to the Brixton Literary Society, in the Lecture Hall of the Independent Church, Brixton.

At 7.30 p.m.—The Institution of Junior Engineers. Joint meeting with Architectural Association at 9, Conduit Street, W. Paper on "Desirability of a Closer Relationship between Architect and the Engineer," by Sydney B. Beale, A.R.I.B.A., and Percy J. Waldroun, P.A.S.I.

Thursday, March 10th, at 8 p.m.—The Institution of Electrical Engineers. Continuation of discussion on Mr. G. Binswanger-Byng's paper on:—"On the Manufacture of Lamps and other Apparatus for 200 Volt Circuits."

Friday, March 11th, at 5 p.m.—Physical Society at the rooms of the Chemical Society, Burlington House. Agenda:—(1) "On Dynamical Illustrations of certain Optical Phenomena," by Prof. J. D. Everett, F.R.S.; (2) "On Properties of Liquid Mixtures," by R. A. Lehfeldt.

Saturday, March 12th, at 7.30 p.m.—At the Westminster Palace Hotel. *Conversazione* of the Institution of Junior Engineers.

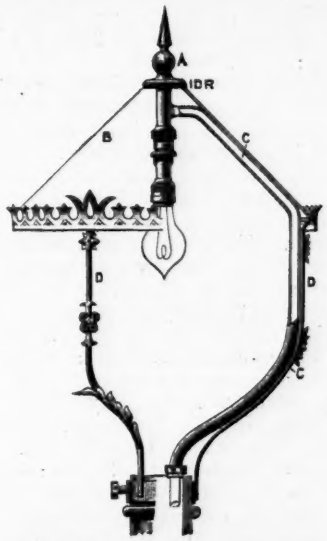
At 10.30 a.m.—Institution of Electrical Engineers. Students' visit to the stations of the Metropolitan Electric Supply Company. Applications to join the party should be made at once to the Students' Hon. Sec. (Mr. S. Grant, 28, St. Mary Abbot's Terrace, W.).

NOTES.

Electrical Engineers' Salaries—England v. America.—Some of our American contemporaries have been drawing attention to the low salaries paid to electrical engineers, scientific demonstrators, and other professional men in this country. The *Electrical World* in some editorial notes on the subject remarks that there is considerable difference of opinion as to the market value of intelligent effort, and in some quarters a disposition to believe it very small. A recent vacancy advertised by a London local authority is taken as a text. £130 per annum was offered for a chief electrical assistant, who had had a thorough electrical and mechanical training, and who was familiar with high tension alternating work. The gentleman appointed was to devote his whole time to the duties of his office. The *Electrical World* passes some severe strictures upon us, strictures which, in the light of recent events, appear to be, in a degree, justified. Our contemporary has, doubtless, overlooked the various appointments which have been made by some English municipalities recently at salaries much smaller than £130 per annum. The recent advertisement published for a "shift engineer" for high tension works at £50 a year (less than £1 a week), to which several correspondents have referred in our columns, we cannot seriously consider to be a true index of the general tendency among electricity committees. If it were so we should not like to prophesy regarding the operation of the plants. We do not know what our trans-Atlantic friends will think of the £50 instance. This is what they say of the £130 appointment:—

> If this case is a fair index of the value of engineering service in England, it is no great matter for wonder that that country is so far behind in electrical progress. Nor is it remarkable that contracts come from there to this country, where there is a more proper recognition of the value of engineering service. A state of things that offers little better than labourer's wages to trained and skilled engineers cannot be productive of a high degree of ability among members of the profession, nor does it offer much incentive to young men to undertake the laborious course of preparation necessary to fit themselves for its exercise. Even in this country, where electrical engineering is notoriously overcrowded, such a rate of wage for such service would be regarded as ridiculous. It seems that, in England, the rates of payment for engineers are not much more than those for high-class mechanics. There a competent mechanic earns $10 a week; here he earns $21. Yet, notwithstanding this great difference, and a further difference against us in the cost of most of the raw materials of manufacture, we can under-sell English makers of electrical machinery in their own market. Perhaps the disregard of the money value of brains shown by the Council of the County Borough of West Ham, or the fact that engineers are so cheap thereabouts, may account for this otherwise anomalous fact.

Street Lighting by Glow Lamps.—The desirability of street lighting with incandescent electric lamps has been a matter of great consideration with the Derby Electric Lighting Committee. To meet this, the borough electrical engineer, Mr. J. E. Stewart, has designed a lantern, shown in the drawing annexed, which so adapts itself to the requirements that it has been decided to replace, in some of the main roads, the existing gas lamps with Mr. Stewart's lantern. As will be seen by the illustration, the lantern can be fitted on already existing gas lamp posts by means of an iron band and set



bolts. The lantern is fitted with a large opal shade, B, which is held in position by means of an ornamental cap, A, which is also provided with an India-rubber ring for weathering purposes. The copper pipe, C, carries the wires, and also forms the main support for the lamp connections, which are so constructed as to enable one or more lamps being fitted. The uprights, D, are of steel, and are riveted to a circumferential T-ring, to which is attached the ornamental copper spinning. The Corporation have approved the design, and will shortly erect some of the lanterns in the main thoroughfares of Derby.

India-Rubber Cables.—With regard to the alarmist reports from Dublin and Burton-upon-Trent, we regret that we have only received one reply from users of cables insulated with this material, although as we stated we should have been glad to have treated any answers we might receive as confidential. Nor have we yet heard from Prof. Kennedy or Mr. F. Bailey as to whether or not it is correct that in each case the cables were condemned without full test or complete examination. Prof. Kennedy based his report presumably to a large extent on the information supplied by the superintendent. Mr. F. Bailey is reported to have condemned the cables at Burton apparently without seeing them, but can this be so? Surely it is of interest to all central station engineers to get reliable information on the subject of cables at the earliest moment. Is not some forthcoming?

Personal.—Mr. Walter P. Adams, A.I.E.E., late of Messrs. Crompton & Co., has taken offices at 35, Queen Victoria Street, where he intends to practice as a consulting engineer, design and superintend electric lighting, power and heating installations, and periodically inspect and report upon any work which may be entrusted to his care. Mr. Adams has had a long and varied experience in electrical work of nearly every kind, five years of his career being passed in assisting Mr. Chamen, the newly appointed Glasgow engineer, and he is an expert in electric heating matters, having managed this department for Messrs. Crompton and Co. He has our best wishes for his success in his new venture.

Mr. F. Kenyon has been appointed resident engineer to the Northwich Electric Supply Company, in place of Mr. T. H. M. Swinburne, resigned.

Another New Storage Battery.—We have received a copy of a statement made by the inventor of a new storage battery, Mr. W. A. Crowdus, giving results of tests showing that at a discharge rate of about 1 ampere per pound of battery, it has a capacity of 18 watt-hours per pound of battery on a run of 9·5 hours' duration. If this result can be verified by an independent expert, it shows a considerable improvement. But the tests shown by the figures given are not what we should accept as quite correct. The rate of output in watts is allowed to fall during the test, as commencing with a rate of 16·8 watts, it gradually falls to 12·6 watts. Now, in practice we require quite as many watts from a battery on a car or a vehicle at the finish of a journey as at the beginning; hence, the tests, to be of practical value, should be made with a variable resistance in circuit, whereby the watts can be kept constant from the start to the finish. If this were done with the cell in question, the watt-hours per pound of battery would be much less than 18. We cannot keep the volts constant, but the amperes ought to be varied to keep the watts constant, if we are to obtain the true working capacity of a traction battery. To allow both amperes and volts to drop during a test gives a spurious result greatly in favour of any cell. A letter from an expert, Mr. Pumpelly, accompanying the inventor's statements says that a 14-lb. cell gives 15 amperes for six hours; this, calculated out, gives, approximately, 12 watt-hours per pound of cell. But, beyond all this, a letter from Mr. John T. Bowden, who holds the patent rights for Great Britain, demands more drastic treatment. He says:—A 3½ horse-power motor is worked from 44 cells of 100 amperes (hours) capacity each. Now, in a report made by Mr. Pumpelly, the 14-lb. cell would just weigh 5½ cwt. if made up on a battery of 44 cells. Pumpelly says this cell gives 100 ampere-hours or 15 amperes for six hours; further, 44 cells will not give more than 85 volts, and 85 volts multiplied by 15 amperes, equals 1,275 watts, or a little more than 1·5 horse-power. How is a 3½ horse-power motor to be driven with a 1½ horse-power battery? The letter informs us that the cell has been tested very carefully; this may be so, but it evidently has not been carefully *reported* upon! If Mr. John T. Bowden believes in reports which appear to be based upon so evidently erroneous figures, he is, we fear, doomed to considerable disappointment if he ever submits his cells to the tests of a competent expert. To get an available 3½ horse-power out of 44 cells, we must obtain a 35-amperes discharge, and at this rate the cells would be exhausted in about two hours, so that it must do the alleged 50 miles at 25 miles an hour. Although things go pretty "slick" in Chicago, their wagons do not seem to fly at this rate. In fact, the figures appear both contradictory and improbable.

Appointment.—Mr. T. U. N. Aldridge has been appointed by the Crown Agents for the Colonies as electrical engineer to the Public Works Department, Lagos, West Africa, for a period of six months.

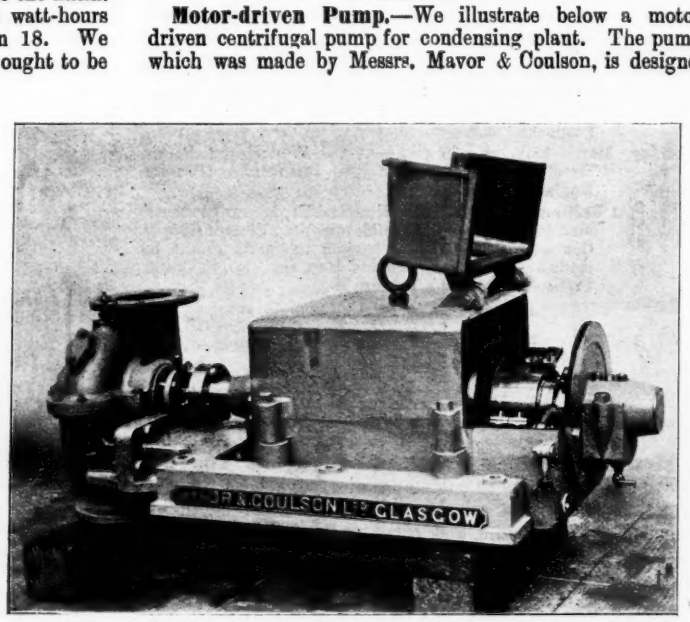
The City Company's Charges.—It is stated that the City of London Electric Lighting Company is reducing its scale of charges, and from the commencement of 1898 the charge for lighting will be 7d. per unit for the first six consumed per 8-C.P. lamp, 6d. for the next four units, 5d. for the next two, and 4d. per unit after. For motive power purposes, the charge will be 3d. per unit for a minimum of 45 hours per week, and 4d. otherwise.

Obituary.—By the last advices from Cape Town we have information of the death, at the early age of 37, of Mr. J. K. Waterman, manager of the Cape Electric Tramways.

We regret to learn of the death of Mr. Thomas Holliday, of the firm of Read Holliday & Sons, Limited, manufacturing chemists and electricians, which occurred on the 1st inst. Mr. Holliday was 57 years of age.

Lord Kelvin's Patents.—Before the Philosophical Society at Glasgow on 23rd ult., Dr. Magnus Maclean, read a paper on "Lord Kelvin's Patents." There were, he said, altogether 47 patents from February 20th, 1858, to September 28th, 1896—a period of 38 years. All of them could be conveniently classified under four heads:—A. Patents relating to improvements in electric telegraphic apparatus. B. Patents relating to improvements in navigational apparatus. C. Patents relating to improvements in generating, regulating, measuring, recording, and integrating electric currents. D. Improvements in valves for fluids. Under the first head (A) there are 11 patents. Under the second head (B) there are 10 patents. Under the third head (C) there are 24 patents. Under the fourth head (D) there are two patents. There are up to September 28th, 1896, 47 patents.

Motor-driven Pump.—We illustrate below a motor-driven centrifugal pump for condensing plant. The pump, which was made by Messrs. Mavor & Coulson, is designed to raise 640 gallons of water per minute against a head of 28 feet. The motor develops 10 brake H.P. at a speed of about 900 revolutions per minute.



Electrical Engineers Royal Engineers Volunteers.—The head-quarters of the corps at 13, Victoria Street, Westminster, are now open during the week, Saturdays excepted, from 11 to 4, between which hours general information in reference to the corps can be given to inquirers. On Monday and Thursday evenings, at 8 p.m., some of the officers are in attendance for the purpose of considering applications and enrolling recruits.

The Diesel Rational Heat Motor.—The Diesel heat motor, of which we have already given a description, appears to be securing a considerable amount of attention, not only here, but in America. The new motor is essentially novel in its principles and decidedly worth study, for it is very different from other motors. Its initial pressure is secured by mechanical compression of air up to the point of ignition of the fuel, and the fall of temperature due to expansion is made up by the continued combustion of added fuel up to the "cut-off" point, after which expansion proceeds in the usual way. So far, petroleum has been the fuel managed successfully, but powdered coal is hoped to be used. Initial pressures of 500 to 600 lbs. have to be dealt with, but the Diesel motor is not large for its power, and is expected to cope with these pressures; but undoubtedly high pressures will for some time yet prove a little difficult to manage. As the tests of Schröter and Gutermuth and others have shown an efficiency of 34 to 35 per cent. for full load, and even 38 to 40 per cent. for half loads, there is very good reason to endeavour to deal with the high pressures. The best gas engine efficiency recorded is, we believe, only 27 per cent. by Dugald Clerk. The increased efficiency at less than full load is a remarkable feature. Altogether, the new motor is likely to receive considerable application in the near future.

Lecture.—On Tuesday last week Mr. H. Kilgour, borough electrical engineer, Cheltenham, lectured at the Gloucester Guildhall, his subject being "Notes on Electric Lighting and Electric Works."

NEW COMPANY REGISTERED.

Electric Installation Company, Limited (56,171).—Registered February 19th with capital £100,000 in £1 shares, to carry on the business of an electric light, telephone and telegraph company in all its branches, and to construct, lay down, establish, fix and carry out all necessary cables, lines, accumulators, lamps and works. The subscribers (with one share each) are:—W. Coffey, 50, High Street, Manchester, manufacturer; J. Boydell, Cowley Hill, St. Helens, merchant; T. Currie, 28, Swan Street, Manchester, factor; H. T. Johnson, Dakeim Lymm, Chester, engineer; R. A. Beaver, 3, Old Hall Street, Liverpool, merchant; R. V. Critchley, 6, St. James's Square, Manchester, chartered accountant; F. F. Bennett, 13, Victoria Buildings, Manchester, engineer. The number of directors is not to be less than five nor more than seven; the first are the first five subscribers; qualification, £250; remuneration as fixed by the company. Registered office, 6, St. James's Square, Manchester.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Thomas G. Poole, Limited (53,736).—This company's statutory return was filed on February 12th. 507 shares have been taken out of a capital of £3,000 in £1 shares, and all are considered as fully paid.

Amazon Telegraph Company, Limited (44,532).—This company's return was filed on January 20th. The capital of £250,000 in £10 shares has been fully subscribed, and paid for in full.

London Electrical Omnibus Company, Limited (47,990).—This company's return was filed on January 21st. The capital of £250,000 in £1 shares, (80,000 deferred). All the deferred and 17,818 ordinary have been taken up, and the deferred are considered as paid. 19s. 6d. per share has been called on the ordinary, and £33,274 2s. 6d. has been paid (including £17 15s. paid in advance). £15,500 9s. is in arrears, and £16,520 8s. 6d. has been received on 32,189 forfeited shares.

CITY NOTES.

The Dover Electricity Supply Company, Limited.

The report to be presented at the fourth annual general meeting of shareholders of the Dover Electricity Supply Company, Limited, to be held at the offices, Park Street, Dover, on Wednesday, March 9th, 1898, at 3.30 o'clock, states that the capital expended during the year amounted to £11,932 7s. 9d., making the total to December 31st last £62,836 7s. 9d. Of the amount thus expended £7,915 0s. 3d. was for additional generating plant necessary for the supply of current to the cars of the Dover Corporation Tramways, the running of which commenced in September last, has given great satisfaction to all concerned, and it is not unlikely that the present service may be increased, additional cars having been lately ordered. In the early part of the year it was decided to issue £25,000 4½ per cent. debenture stock, and the whole was subscribed for at a considerable premium, of which the balance, amounting to £761 2s. 6d., after payment of all legal and other charges in connection with the issue, has been applied to reduction of the previous debits to revenue account.

The directors consider the result of the year's working very satisfactory, since, instead of a loss of £455 19s. 11d., as in the previous year, there has been a gross profit of £1,127 17s. 5d. on revenue account. The company may now be considered as fairly established on a profit-earning basis, and the directors believe that in future years the annual increments in gross profits will at least equal, if not exceed, those for the year just ended, as during the construction and after the completion of the national harbour at Dover the trade of the town will largely increase, to the benefit of all its present established undertakings.

During the year applications have been received for the equivalent of 2,748 8-C.P. lamps, including nine additional arc lamps for street lighting (of which there are now 40 in all), making the total applied for on December 31st last 10,376, and of these 10,137 were then connected to the company's mains.

With the view of inducing an increased average daily use of electricity by householders, your directors decided to adopt, as from July 1st last, the demand indicator system of charging, and to reduce the cost of current after the first two hours' daily consumption from 5d. to 3½d. per unit. This system has been introduced in Brighton and many other towns, where it has given general satisfaction; and your directors believe that as its advantages become more generally known, both consumers and the company will correspondingly benefit.

The retiring directors are Mr. C. W. Bagshawe and Mr. R. Percy Sellon, who, being eligible, offer themselves for re-election. The auditor, Mr. R. H. Marsh, chartered accountant, also retires, and is eligible for re-election.

The Richmond (Surrey) Electric Light and Power Company, Limited.

The report presented to the shareholders at the fourth ordinary general meeting of the company, held at the registered offices of the company, Moorgate Court, yesterday, states that the directors beg to submit their report and statement of accounts for the year ended December 31st, 1897. The capital expended during the year amounted to £3,828 17s. 1d., making the total expenditure at December 31st last £44,793 11s. 9d.

Of the amount expended during the period under review, the principal items are in respect of mains and accumulators, the latter of which have been increased to more than double their previous capacity. The balance to credit of revenue account, including the amount brought forward, and after payment of interest, depreciation and reduction of suspense account, is £1,072 18s., as against £33 14s. 9d. in 1896. Out of this sum the directors recommend the payment of a dividend on the ordinary shares of the company at the rate of 3 per cent. for the year ended December 31st, 1897, which will leave a balance of £133 to be carried forward to next account.

The total number of lamps connected on December 31st last was equivalent to 9,512 8-C.P., being an increase for the year of 2,387. In order to meet the growing demand for current, additional plant will be installed in time for next winter's lighting, and further extensions of mains have already been decided upon.

The retiring director is Mr. F. W. Reynolds, who, being eligible, offers himself for re-election. Mr. R. H. Marsh, the auditor, also retires, and is eligible for re-election.

Mr. Frederick W. Reynolds (chairman), presided at the meeting of the company, and in moving the adoption of the report, said he congratulated them at last on reaching a small dividend. The improvement shown in 1896, had been maintained during the year, which was very satisfactory considering the condition of affairs which prevailed in Richmond. The receipts from the sale of current, showed the satisfactory increase of £1,116 15s. 3d., and the total income for the year was £4,468 16s. 6d., as compared with £3,194 8s. 3d. in 1896. The working cost £2,235 11s. 2d., as compared with £2,031 10s. 10d., being only £204 0s. 6d. increase, while the current sold increased to 41,872 units. After payment of interest, and provision for depreciation, &c., they had £1,072 18s. left, out of which a dividend was recommended of 3 per cent. That was the first dividend, and he thought it augured well for the future of the company. The lamps connected on December 31st were equivalent to 39,512 8-candle-power lamps, an increase of 2,387 over last year. There were applications for a further 425 8-candle-power lamps, so that with those connected and those applied for, they had now 10,000 lamps. The total units sold was 138,916, against 97,044 in 1896. In view of the encouraging prospects, it was the intention of the board to lay down more plant for the winter lighting, and they also intended to extend the company's mains, which would go into some of the principal residential streets of Richmond.

The Chevalier Soares seconded the motion, and it was agreed to.

The Hove Electric Lighting Company, Limited.

The report of the directors to be presented at the annual general meeting of the shareholders at the City Terminus Hotel, Cannon Street, in the City of London, on Monday, March 7th, 1898, at 12 o'clock noon precisely, states that the progress and improvement in the position of the company continue satisfactory.

As stated in their report last year, the directors made a very considerable reduction, from January 1st, 1897, in the price of current, charging the consumers for the first hour 6d. per unit and for all current subsequently consumed 4d. per unit only. This reduction, which practically amounts to 20 per cent. in the charge for current, has had the effect anticipated of increasing the number of consumers and the consumption of electricity to such an extent that the large reduction is more than compensated for by the increased consumption.

The revenue from the sale of current has increased to £6,838 17s. 10d., and after debiting profit and loss account with the cost of generation and distribution of electricity, and management expenses, there remains a net profit for the year of £3,602 9s. 8d. compared with £3,114 5s. 6d. in 1896. To this amount must be added £183 7s. 10d. brought forward from last year, increasing the amount to be dealt with to £3,785 17s. 6d., and after deducting debenture interest paid and accrued and the interim dividend paid in October last, there remains a net balance of £2,092 7s. 11d. at the credit of the revenue account.

The directors propose to write the sum of £150 off preliminary expenses account, to place £600 to the reserve fund, to declare a dividend (payable on April 15th next) at the rate of 6 per cent. per annum for the half-year on the share capital (making, with the interim dividend, 5 per cent. for the year), and to carry the balance, £218 7s. 2d., forward. The number of lamps attached to the company's system has increased to the equivalent, at December 31st last, of 27,777 8-C.P. lamps, and the number or consumers to 397, compared to 21,756 lamps and 314 consumers at December 31st, 1896.

Out of the sum of £600 which has to be set aside for repairs and maintenance, in accordance with the contract with the Hove Commissioners, the unexpended sum of £390 13s. 11d. has been placed to the depreciation and maintenance reserve fund, bringing the total of this account to £914 10s., while the general reserve fund, by the addition now proposed to be made, will stand at £2,259 17s.

Since the date of the last report the directors have issued £2,400 of 4 per cent. debenture stock, bringing the total amount issued at the present date to £17,000.

The increase of the company's business, and the continued applications for supply of current from residents in new streets entail upon the company further outlay on mains and machinery, for which additional capital is required. The directors, therefore, propose to increase the capital of the company to £50,000 by the creation of 2,000 new shares of £5 each, ranking *pari passu* with the existing shares, and the necessary resolution for giving effect to this proposal is contained in the accompanying notice of meeting. The directors propose to make an early issue of 1,000 of these shares which will be offered to the whole of the members of the company, *pro rata*, at a premium.

A resolution will also be submitted for consideration, increasing the limit of the directors' borrowing powers from £25,000 to £50,000.

The County of London and Brush Provincial Electric Lighting Company, Limited.

The report to be presented to the shareholders at the fourth ordinary general meeting of the company to be held at Winchester House, Old Broad Street, London, E.C., at 12 o'clock noon, on Monday, March 14th, 1898, states that the capital expenditure during the year in respect of the company's London districts amounted to £141,066 3s. 9d. Of this sum £138,078 5s. 10d. has been expended at St. Luke's and Clerkenwell and at Wandsworth, making the total expenditure on the two London stations up to December 31st last, £410,801 12s. 1d.

This expenditure was met by the balance of instalments falling due on the second issue of 10,000 6 per cent. preference shares, and by the sale at a premium of the balance of the second issue of ordinary shares. In order to provide funds for additional requirements during the current year, a further 10,000 ordinary shares at par were allotted *pro rata* to the ordinary shareholders on December 6th last.

The premium received on the balance of the second issue of ordinary shares has been applied as follows:—

	£	s.	d.
To reduction of general preliminary expenses	3,253	19	6
To writing off costs in connection with applications for provisional orders	889	15	6
Amount carried to reserve (raising this item to £5,000)	1,500	0	0

The interests of the company in the Bournemouth and District Electric Supply Company, Limited, have been disposed of to the Bournemouth and Poole Electricity Supply Company, Limited, at a substantial profit. Your directors deeming it to your advantage to retain an interest in the latter company, applied for and received an allotment of ordinary shares at par.

The net revenue for the year, including the balance from last account, and after payment of proportion of rents, rates, taxes, interest, and general establishment charges, is £21,400 14s. 2d. Out of this sum an interim dividend on the preference shares for the half-year ended June 30th last, at the rate of 6 per cent. per annum has been paid; and the directors now recommend that a further dividend on the preference capital for the half-year just ended be declared at the same rate. This will leave a balance of £10,090 14s. 2d., which it is proposed to carry forward.

The company's two London generating stations are now fully equipped and in good running order, having a joint plant capacity sufficient for the supply of 120,000 8-C.P. lamps connected. It is intended to supply the company's districts north of the Thames from the St. Luke's station in City Road, and those on the south side of the river from the station on the Wandle.

For the information of shareholders a map is attached to the report, showing:—(*a*) Districts where current is now being supplied. (*b*) Districts wherein works are in progress. (*c*) Districts for which provisional orders have been obtained (works not yet commenced). (*d*) Districts where the consents of the local authorities have been obtained to the company's application for provisional orders.

The retiring directors are Mr. B. H. Van Tromp and Mr. R. Percy Sellon, who are eligible for re-election.

LONDON STATIONS.

St. Luke's and Clerkenwell.—The station buildings and the equipment thereof are practically completed. The plant installed is capable of supplying 80,000 8-C.P. lamps connected. The equivalent of 23,757 8-C.P. lamps were connected to the mains at December 31st last, showing an increase of 9,578 for the year; and applications representing a further 1,073 were then awaiting connection. A considerable demand having arisen for motive power, separate mains have been laid down, and a supply of current for power purposes is now available in most of the important thoroughfares in the district.

Holborn (Eastern Portion).—A provisional order for the eastern portion of this district was granted to the company by the Board of Trade, and confirmed in the last session of Parliament. The work of laying mains in the compulsory area was at once taken in hand, and current is now being supplied to consumers within this district from the generating station in City Road. The company's application to the Board of Trade for a provisional order for the western portion of Holborn, and for the adjoining district of St. Giles-in-the-Fields, has received the consent of the local authorities.

Wandsworth.—The station buildings on the Wandle were completed during the year, and the capacity of the plant there installed is equal to 40,000 8-C.P. lamps connected. The company's mains have been carried into new neighbourhoods, and further extensions are in progress. The supply of current was commenced in the early part of 1897, and since September last has been available throughout the 24 hours. The equivalent of 13,907 8-C.P. lamps were connected to the mains at December 31st last, showing an increase of 13,690 for the year, and applications representing a further 2,927 were then awaiting connection.

Camberwell.—The work of laying mains in the compulsory streets within this district has been commenced, and it is expected that by next autumn a supply of current will be available.

Mile End Old Town, St. George's-in-the-East, and the district of the Limehouse District Board of Works.—Provisional orders for these districts were granted by the Board of Trade in 1896, and confirmed by Parliament in 1897.

PROVINCIAL STATIONS.

The Dover Electricity Supply Company, Limited.—In the past year an important addition was made to the Dover Station by the laying down of generating plant for the supply of current to the Corporation tramways. The running of the trams by electricity was commenced in September last. In the second completed year of the working of this station the gross profits amounted to £1,127 17s. 5d., as against a loss in 1896, and the company may now be considered as fairly established on a profit-earning basis. The equivalent of 10,137 8-C.P. lamps were connected to the mains at December 31st last, showing an increase of 2,619 for the year (including nine arc lamps for street lighting); and applications representing a further 239 were then awaiting connection. In the early part of 1897 the Dover Company made an issue of £25,000 4½ per cent. debenture stock, the interest upon which is guaranteed by the company.

The Richmond (Surrey) Electric Light and Power Company, Limited.—A considerable improvement is shown in this company's accounts for the year under review. The gross profits amounted to £2,233 5s. 4d., which allows of a dividend of 3 per cent. on the share capital, after providing for interest charges and reserve for depreciation of plant, &c. The equivalent of 9,512 8-C.P. lamps were connected to the mains at December 31st last, showing an increase of 2,387 during the year; and applications representing a further 220 were then awaiting connection. In order to meet the increasing demand for current at this station, it is intended to lay down additional plant during the present year, and further extensions of mains have been decided upon.

Isle of Man Tramways Company.

The report of the directors for the year ended December 31st last, to be submitted at the general meeting to be held on the 10th prox., states that the balance of profit and loss account, after providing £6,500 for debenture interest, is £11,154. The directors propose dividends at the rate of 6 per cent. on the preference, and 7 per cent. on the ordinary shares, absorbing £10,850, of which £5,669 has been paid in interim dividends, and that the balance of £304 be carried forward. The loss on the first half-year's working of the cable section has been exceptionally heavy, owing to many unforeseen circumstances and through frequent stoppages. With the experience gained, the management confidently hope next year to have a satisfactory return on the cable lines. It is expected that the new electric tramway from Laxey to Ramsey, now in course of construction, and which will be worked as a separate undertaking, will be opened for next summer's traffic, and will bring considerable increase of revenue on the company's present lines.

Telegraph Construction and Maintenance Company, Limited.

Sir Anthony H. Hoskins, who presided at the ordinary meeting of this company, held on Tuesday, regretted the absence of the chairman, Sir Robert Herbert, through illness. They had had no important contract to carry out during the period under review, but their factories at Wharf Road and East Greenwich had been actively employed, and they were able to maintain the dividend at the same rate, 15 per cent., as last year. They carried forward a somewhat smaller amount, but they consider it better to do that, rather than to lower the dividend. They would be interested to learn that this was the 50th year of the most important branch of the manufacture—the insulation of telegraph wires. Their gutta-percha works were started in 1845, although it was not till 1848 that the insulating properties of gutta-percha were generally recognised. The total amount of raw gutta imported into this country had been officially stated to be 84,000 tons, of which he believed 40,000 had been used by their company. The gutta-percha manufactured by them had been mostly for submarine cables, of which they had made 145,000 knots of various sized cores. Gutta remained to-day un-

rivalled as an insulator for submarine cable cores. It was interesting to note that they were manufacturing for the British Postal Telegraphs a telegraph cable, 60 knots in length, to be laid between this country and Ireland, having a core of novel design. It possessed considerable electrical advantages, and they hoped the form would solve the question of telephonic communication. The cable had been invented by their engineer, Mr. Willoughby Smith, and his assistant, Mr. Granville, and a small section had been laid in Southampton Water, and had been successful. They had entered into a contract for building a new cable steamer, which would be the largest telegraph ship in the world. In planning and designing her they had had the accumulated experience extending over a good many years, and they could reasonably expect the vessel to be thoroughly up to date. It was absolutely necessary that a vessel of her capacity and dimensions should be brought into use with a view to securing contracts that may be forthcoming in the future. She would be capable of lifting a dead weight of 8,000 tons, and that would enable her to carry the largest ocean cable in one length. It would be fitted with twin screws, the engines and boilers would be of a modern type, and would give a speed of 12 knots per hour on a moderate consumption of coal.

After one or two remarks from shareholders, one of whom elicited from the chairman the fact that the new cable ship would be finished in early autumn, the report was adopted.

The City of London Electric Lighting Company, Limited.

The report presented to the shareholders at the ordinary general meeting held on Wednesday stated that the expenditure on capital account during the year ended December 31st, 1897, amounted to £82,085 17s. Details of this outlay are given in the capital account No. III.

Revenue.

			£ s. d.
The total revenue for the year was			190,573 12 11
From which must be deducted the following items:—			
Expenses of generation and distribution	£42,923 10 8		
Rents, rates, taxes, general charges	23,980 19 6		
Allowances to consumers	14,760 19 9		
Transfer to depreciation fund No. 1	17,000 0 0		
Transfer to reserve fund	3,528 0 0		
Amount written off suspense account	1,338 0 8		
			103,551 10 7
Leaving			87,022 2 4
To which must be added the balance brought forward from 1896			1,415 3 1
Making a total available revenue of ...			88,437 5 5
Of this sum the following amounts have been distributed:—			
(*a*) Interest on debenture stock for year ended December 31st, 1897	£20,000 0 0		
(*b*) Interim dividend on £400,000 6 per cent. preference shares, half-year to June 30th last ...	12,000 0 0		
			32,000 0 0
Leaving for further distribution			£56,437 5 5

The directors now recommend the payment of the following dividends, subject to the deduction of income-tax, to members registered in the books of the company on February 16th, 1898.

Preference Shares.—6s. per share for the six months ended December 31st, 1897, making, with the interim dividend already paid, a total distribution of 12s. per share, or at the full rate of 6 per cent. per annum.

Ordinary Shares, Nos. 40,001 to 80,000.—£1 per share for the 12 months ended December 31st, 1897, being at the rate of 10 per cent. per annum.

Ordinary Shares, Nos. 80,001 to 90,000 (February, 1897, issue).—10s. 7d. per share, being at the rate of 10 per cent. per annum, calculated from the due dates of the respective instalments to December 31st, 1897.

This will absorb £55,381 18s. 10d., and leave a balance of £1,055 6s. 7d. to be carried forward. It is proposed that the respective dividends shall be paid on March 3rd, 1898.

The statutory provision for depreciation and reserve funds in accordance with the City of London Electric Lighting Act, 1893, has been made, of which £20,528 have been set aside out of revenue. The generation and distribution expenses for the year, including repairs and renewals, were 31·3 per cent. of the earnings, as compared with 34 per cent. in 1896, 36·87 for 1895, 46 for 1894, and 54·2 for 1893.

The progress made by the company will be seen by the following comparative statements, which show the position as it was in 1892 and at subsequent periods:—

Number of Customers and Lamps Connected.

	Dec. 31st, 1892.	Dec. 31st, 1893.	Dec. 31st, 1894.	Dec. 31st, 1895.	Dec. 31st, 1896.	Dec. 31st, 1897.
Number of customers being supplied	212	1,080	2,740	4,230	5,303	6 322
Number (equivalent) of 8-C.P. lamps connected	20,241	65,341	135,460	195,317	247,785	296,012

On February 9th, 1898, there were 316,705 8-C.P. lamps (equivalent) applied for, out of which 302,871 were connected.

Statement of Income as Shown in the Audited Statements of Accounts Issued by the Company.

	For the period to Dec. 31st, 1892.	For the year ended Dec. 31st, 1893.	For the year ended Dec. 31st, 1894.	For the year ended Dec. 31st, 1895.	For the year ended Dec. 31st, 1896.	For the year ended Dec. 31st, 1897.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Gross revenue (after deducting allowances to consumers)	12,450 5 4	39,662 17 9	68,863 19 3	106,999 17 2	146,946 14 7	175,792 13 2
Net revenue available for depreciation, reserve fund, interest on debenture stock and dividends	500 (est.)	16,940 14 10	34,865 2 6	59,100 5 11	85,701 8 3	107,550 2 4

The ordinary general meeting of the shareholders of the above company was held on Wednesday at Winchester House, Old Broad Street, Sir David L. Salomons presiding.

The Chairman, in proposing the adoption of the report, said it was satisfactory that the directors were able to recommend a dividend at the rate of 10 per cent. per annum. To effect that, it had been necessary to take £5,000 from the premium fund towards depreciation, and approximately a similar sum was taken last year for the same purpose. In 1896 the revenue was aided, from the fact that there was a sum somewhat exceeding £5,000 from the profits on investments; also the sum that was put to the depreciation fund, making in all £10,000 added to the revenue. In other words, last year they paid 7 per cent. dividend with the aid of that additional £10,000; but this year they would be able to pay 10 per cent.—with the approval of the shareholders—without having had the advantage of that additional £10,000. Those facts showed that the business was progressive. It also proved that which he had often referred to, that when the business had reached a certain point, they would be able to make much larger profits at a very small additional cost. As they could well understand, the standing charges remained virtually the same, it was simply a question of burning a little more coal, and keeping the machinery running for a longer period to produce a larger output of current. In 1896 about £10,000 was taken from the premium fund to assist the depreciation fund number two, and this year it was proposed to take £20,000 to add to that fund, as they considered that that fund being a voluntary one on the part of the board, should be kept up to a fair amount to meet any contingencies that might arise in the future. The expenditure on capital account during the year had amounted to £82,085. It might be curious to notice that their freehold investments appeared to be less than they were the year before, but that was really to be accounted for by the fact that some of the investments had been shifted from a general heading, and put definitely to represent the depreciation and reserve fund. The capital expenditure had increased, and also the expenditure for running the company during the year, which was due to their having supplied a greater amount of current. It was very satisfactory to know that the demand for the supply of electric energy continued to increase. The number of customers on February 23rd was 6,517, the number of lamps applied for was 318,741, and the number of lamps connected to the circuits 305,163. That afforded abundant proof that not only was the electric light appreciated in the City, but also that they had given satisfaction to their customers. The great fire in Cripplegate at one time gave the directors very great anxiety, but he was very glad to be able to say that the damage caused to the company was only nominal—between £200 and £300 would cover their entire loss. It was said it was an ill wind that blew nobody any good, and it was possible that, as a result of that fire, their company might benefit, for they were sending round a circular to the builders of the new premises that were to be erected, pointing out the advantages that would accrue by wiring the premises for the electric light. He had had a letter from a shareholder who had asked whether the board could not see their way to paying an interim dividend in the future. To that he would say that, if the business continued to prosper in the coming years as it had done in the past, the directors saw no objection to that course, seeing that it would meet the wishes of many shareholders. He would like to point out, however, that any interim dividend would necessarily be small, as the first half of the year was always a small one. Referring to the relations of the company with the City authorities, the chairman said that the directors were anxious

to meet the Corporation in all matters in a fair and even conciliatory spirit. They were a business company carrying on operations for the purpose of obtaining a profit on their investment, and therefore had no desire to enter into litigation, and they would only have recourse to the law courts to enforce their just rights. If such a position were forced upon them the board would protect the rights of the shareholders; but, as he had said, they desired to act in harmony with the authorities. It had been decided to reduce the maximum price from 8d. to 7d. per unit, and the board hoped to reduce the price still further as the exigencies of the business admitted of it. In order to give the public the fullest possible benefit, they had decided to make that reduction date back from January 1st last.

The report was adopted.

The retiring directors—Mr. Edward Lucas and Mr. F. W. Reynolds—having been re-elected, a similar proposition was agreed to with reference to the auditors, Messrs. W. H. Pannell & Co.

A vote of thanks to the Chairman for presiding closed the proceedings.

Notting Hill Electric Lighting Company.

The annual general meeting of this company was held at Winchester House, on Wednesday, Sir William Crookes presiding.

Referring to share capital account, the Chairman said the whole £100,000 of share capital had been issued and paid up. In the loan capital there was still £40,000 of 4 per cent. debentures available for issue against further capital expenditure. By making use of these the shareholders reap the benefit, as the debentures carried interest at 4 per cent. only, whereas a further issue of shares would rank for dividend with the old ones, and would therefore have to receive the full 6 per cent. By issuing debentures, however, the odd 2 per cent. goes to increase the share dividends. During the year the directors allotted £10,000 of the 4 per cent. first mortgage debentures at £106 per cent., being part of an issue of £50,000 secured on the company's undertaking by a trust deed. They anticipated requiring about £11,000 this year, and the issue price of the debentures will be increased to £107 10s. per cent. The amount of capital expended on lands, buildings, mains, and machinery, was £3,184 in excess of the amount received from shares and debentures. Very little capital was expended during the year except on new mains, which represent £11,769 of the total expenditure of £14,079. The reason for this large expenditure is that they had now seriously commenced to lay mains in the principal streets of the new area, most of the compulsory ones being already supplied with current. They had every reason to be satisfied with the number of customers on the new extensions, which appeared an almost certain source of additional revenue; but there was still a large field for further development. Other small extensions of the mains had to be made in the old area, and they were always prepared to extend into any street where the demand appeared sufficient to guard against a loss being incurred on the capital employed. The revenue account was in a very satisfactory state, the number of units sold having increased during the past 12 months from 230,787 to 354,969, or 50 per cent., and the total revenue from £8,550 to £11,620. The increase in the revenue, compared with the previous year, is over £3,000, but the expenses show an increase of only about £930. The principal increases were for coal, repairs, and rates. The whole of the machinery and mains are kept in an efficient state of repair, the entire cost being taken out of revenue. He took the opportunity of expressing their entire satisfaction at the excellent manner in which their engineering staff, under Mr. Schultz, had carried out the duties devolving on them, more especially in view of the very anxious times at the end of the year. Owing to the labour troubles at that time in the engineering trade, the contractors were unable to deliver the large engine and dynamo which should have been completed last summer ready for the winter load. Had one of the machines failed at the critical moment, they would have been in a most awkward predicament, having no spare plant whatever to fall back upon. Happily, no accident occurred, and the new machinery was delivered last week.

A table was then given showing the progress of the company. Their revenue per 8-C.P. lamp still continued low, being about 6s. only, showing that their district was not so good as most of the others in London, where the average consumption per lamp was above 10s. They hoped to derive considerable benefit from their contract with the National Electric Free Wiring Company, who undertake to wire houses and provide suitable fittings free of initial cost to the consumer, who merely had to pay an additional 1d. per unit, which 1d. is handed over to the Free Wiring Company. Already 20 houses had been connected on those terms. They had every reason to be satisfied with the result of the reduction in the price per unit. to 6d. at 200 volts; and although their principal thought must be to benefit shareholders, they must not overlook the claims of those who supply the dividends, viz., the consumers. As many of their shareholders were also using their light, he could assure them that their interests would be very carefully considered, and immediately it was possible to make a further reduction they could rely that this would be done. The dividend of 6 per cent. on the ordinary shares, which they now recommended, marked a period in their history. After this was paid, preference and ordinary shares ranked equally for dividend, and the founders' shares came in for their proportion. To simplify matters, they proposed to regard the ordinary dividend as a 6 per cent. one, payable half yearly, and at the end of the second half year proposed to pay in addition such bonus as the profits may allow. The total amount of profits available for dividend, after payment of the 6 per cent., would be divided into two moieties, and one moiety would go to the 9,450 preference and ordinary shares *pro rata*, and the other moiety to the 550 founders' shares *pro rata*.

After some little discussion the report was adopted.

Henley's Telegraph Company, Limited.

Mr. Sydney Gedge, M.P., presided at a general meeting of this company, which was held last Friday at the offices of the company, Martin's Lane, E.C., and referred to the fact that the company for some years had been going on well, and improving in every way its position and its prospects. He congratulated the shareholders upon the success which had attended the efforts of those who had the management in their hands. Dwelling for a moment upon the progress that had been made during the five years, the chairman said in 1893 they issued £30,000 preference shares partly to pay off debts, and partly to provide fresh capital. The benefit of that was felt during the following year, for they made a very substantial profit of £10,771, and were able to pay a dividend of 5 per cent. They also raised fresh debentures at a lower rate of interest, to replace older ones, and they practically increased their capital by £12,000 at an increase of interest of only £253. They commenced to pay better dividends, and in 1895, when they wanted more capital, they increased from the nominal £70,000 to £100,000, the whole of which issue was taken up at par by their own shareholders and friends. It was found necessary in 1896 and last year to further increase the capital, and they issued £25,000 of further capital at a very considerable premium, making, in fact, £15,000, which had been added to the reserve fund. Their business was increasing so rapidly, and as they found it necessary to have the best of machinery, it was not at all unlikely, before the year ended, that they would have to issue another £25,000, although shareholders must not expect to get them at the same price as the last. The profits for the last five years had been as follows:—

	Profits.	Paid in dividends.
1893	£10,780	£6,000
1894	16,450	6,800
1895	21,820	9,500
	(£1,600 from previous year)	
1896	26,080	12,400
	(less £500 to directors)	
1897	29,585	15,800

Their net profits had continuously progressed, and the sums paid in dividends had also increased year by year, and at the same time they had been able to pay dividends out of profits actually earned. The actual earnings had paid interest on debentures, and during the five years they had written off £10,000 for depreciation, added £20,000 to the reserve fund, besides the £15,000 profit on issuing shares, they had paid in dividends £50,500, carrying forward £12,700 to 1898. Referring to the present accounts, they would see that the value of stock had increased, but it was not unsaleable stock, but represented goods which they might have to supply at 24 hours' notice. Referring to the effects of the strike, the chairman said that in their case men of inferior position had been put to do the work of the skilled workmen, and the result had been that they had done more and better work.

After some remarks from shareholders the accounts were adopted.

Stock Exchange Notices.—The Stock Exchange Committee has appointed Thursday, March 10th, a special settling day as under:—Chelsea Electricity Supply Company, Limited—Further issue of 8,000 ordinary shares of £5 each, fully paid, Nos 32,501 to 40,500; and National Electric Free Wiring Company, Limited—100,000 shares of £1 each, 5s. paid, Nos. 1 to 100,000. The Committee has also ordered the under-mentioned securities to be quoted in the official list:—Edmundson's Electricity Corporation, Limited—17,400 ordinary shares, Nos. 1 to 17,400. Halifax and Bermudas Cable Company, Limited—£97,800 4½ per cent. first mortgage debentures, within Nos. 1 to 1,200.

Brazilian Submarine Telegraph Company, Limited.—The directors of this company have to-day declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income-tax, for the quarter ended December 31st last, and payable on March 25th. The transfer books of this company will be closed from the 18th to the 24th inst., both days inclusive.

The House-to-House Electric Light Supply Company, Limited.—The transfer registers of this company will be closed from the 2nd inst. to the 12th inst., both days inclusive for the preparation of dividend warrants.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending July 25th, 1898, were £2,290 8s. 11d.; corresponding period, 1897, £2,218 7s. 2d.; increase, £72 1s. 9d.

The City and South London Railway Company.—The receipts for the week ending February 27th, 1898, were £1,065; week ending February 28th, 1897, £996; increase, £69; total receipts for half-year, 1898, £9,680; corresponding period, 1897, £9,713; decrease, £33.

The Dublin Southern District (Electric) Tramways Company.—The receipts for week ending Friday, February 25th, 1898, were £352 0s. 1d.; corresponding week last year, £508 11s. 3d.; decrease, £156 11s. 2d.; passengers carried, 61,674; corresponding week last year, 77,074; aggregate to date, £3,215 12s. 9d.; aggregate to date last year, £3,456 1s. 11d.; decrease to date, £240 9s. 2d.; mileage open, 8 miles, as against 8 miles for the corresponding period of last year. Cars, 1898, 207; 1897, 292. Miles, 1898, 18,795; 1897, 26,060.

The Liverpool Overhead Railway Company.—The receipts for the week ending February 27th, 1898, amounted to £1,300; corresponding week last year, £1,275; increase, £25.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending February 25th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,396.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, Feb. 23rd.	Closing Quotation. March 2nd.	Business done during week ended March 2nd, 1898. Highest.	Lowest.
137,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	...	...	100 —104	100 -104	...	...
25,000	Amazon Telegraph, Limited, shares	10	...	...	...	6 — 7	6½ — 7½	...	...
125,000	Do. do. 5% Debs. Red.	100	...	...	...	93 — 96	93 — 96	...	...
923,960£	Anglo-American Teleg., Ltd.	Stock	£2 9s.	£2 13s.	3 %	59 — 61	59 — 61	60½	59
3,038,020£	Do. do. 5 % Pref.	Stock	£4 18s.	£5 6s.	6 %	107½ 108½	107½ 108½	108½	107½
3,038,020£	Do. do. Defd.	Stock	...	...	...	11⅜— 12⅛	11⅜— 12⅛	12 1/16	11⅛
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	...	...	16⅞— 17⅛	16⅞— 17⅛	17 1/16	16⅞
75,000£	Do. do. 5 %, Debs., 2nd series, 1926	100	5 %	...	...	112 —116	112 —116	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	4 %	4 %	...	3 — 3½	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	...	187 —192	187 —192	...	...
653,586£	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	106 —108	106 —108	106½	106½
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	2 %	...	⅞— 1	⅞— 1	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	...	7½ — 8½	7 — 8 xd	7⅝	7½
6,000	Do. 10 % Pref.	10	10 %	10 %	...	15½ — 16½	14½ — 15½xd	15½	14½
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	10 — 11	10 — 11	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000	50	4½%	4½%	...	103 —106%	103 —106%	...	...
60,710	Direct United States Cable, Ltd.	20	2½%	2½%	...	10⅜ — 11½	10⅜ — 11½	11½	...
120,000	Direct West India Cable 4½% Reg. Deb.	100	...	...	...	98 —101	98 —101	99¾	99
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	18 — 18½	18 — 18½	18⅝	18
70,000	Do. 6 % Cum. Pref.	10	6	6%	...	19 — 20	19 — 20	19⅜	...
89,900£	Do. 5 % Debs., repay. August, 1899	100	5 %	5%	...	100 —103	100 —103	...	...
1,302,615£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4%	...	131 —134	131 —134	131	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd.	10	7 %	7½	...	18⅜ — 19½	18⅜ — 19½	19	18⅞
25,200£	{ Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,849, 2,976 to 4,326	}100	5 %	5%	...	99 — 103	99 —103	...	...
100,500£	Do do. Bearer, 1,850—2,975 and 4,327—5,460	100	5 %	5%	...	100 —103	100 —103	101½	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4%	...	130 —133	130 —133	...	...
51,100£	{ Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	}100	5 %	5%	...	99 —103	99 —103	...	...
69,200£	Do do. do. to bearer, 2,344 to 5,500	100	5 %	5%	...	100 —103	100 —103	100½	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4%	...	102 —105	102 —105	101	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 2,000	25	4 %	4%	...	108 —111%	108 —111 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	12 — 12½	12 — 12½	12⅜	12
180,042	Do. do. 6 % Pref.	10	6 %	6%	...	17⅜ — 18½	17⅜ — 18½	18½	17⅜
150,000	Great Northern Teleg. Company of Copenhagen	10	10 %	10%	...	27½ — 28½	28½ — 29½	28⅜	...
160,000£	Do. do. do. 5 % Debs.	100	5 %	5%	...	101 —104	100 —103 xd	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10%	...	52 — 55	52 — 55	...	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6%	...	108 - 111	106 —109 xd	106½	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000	5	4 %	...	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5½%	5½%	6 %	6⅞ — 7⅛	6⅞ — 6¾xd	6 15/16	6 13/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18 xd	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	16½	15⅝
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6½	5⅝ — 6¼xd	5 15/16	...
130,766	{ Do. do. Nos. 119,235 to 250,000, £5 paid	} 5	...	...	5 %	6 — 6½	5⅝— 6¼xd	...	...
329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	104 —109	104 —109	105½	105
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅜ — ⅝	⅜ — ⅝	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar Debs, 1 to 1,000	100	4 %	4 %	...	105 —108	105 —108	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	8 — 9	8 — 9	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	139 —144	139 —144	...	...
58,000	United River Plate Teleph., Ltd.	5	4 %	...	...	4 — 4½	4 — 4½	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	...	...	101 —106	103 —107	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	nil	...	4½ - 4⅝	4½— 4⅝	...	...
213,400£	Do do. 5 % Debs.	100	5 %	5 %	...	103 —106	101 —104 xd	...	...
64,268	Western and Brazilian Teleg., Ltd.	15	3 %	2 %	...	10½ — 10⅝	11½ — 12	11½	10½
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %	...	7½ — 8	7½ — 8	7⅝	...
33,129	Do. do. do. Def. Ord.	7½	1 %	...	...	3½ — 3⅝	4 — 4½	4⅜	3 5/16
382,230	Do. do. do. 4 % Deb. Stock Red.	Stock	...	...	...	105 —107	106 —108	106⅝	...
88,321	West India and Panama Teleg., Ltd.	10	⅞%	1 %	...	½ — ⅝	½ — ⅝	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	8 — 8½	8 — 8½	8⅜	8
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	5 — 7	5 — 7	...	...
80,000£	Do. do 5 % Debs. No. 1 to 1,600	100	5 %	5 %	...	105 -108	105 —108	...	...
163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds	$1000	7 %	7%	...	105 —110	105 —110	...	...
160,100£	Do. do. 6 % Ster. Bonds	100	6 %	6%	...	100 —105	100 —105 xd	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	6 %	7 %	14 — 15	14 — 15	14 1/16	14 1/16
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6¼	6 1/16	...
25,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277	5	5 %	5 %	...	11½ — 12	11½ — 12	11 15/16	...
60,000	Do. do. do. 4½ % Deb. Stock Red.	Stock	4½%	4½%	...	115 —117	115 —117	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	7 %	10 %	28½ — 29½	28½ - 29½	29½	28½
10,000	Do. do. Prov. Certs.	5	...	...	10 %	28 — 29	28 — 29	...	...
10,000	Do. do. Nos. 90,001 to 100,000 £2 pd.	10	...	...	...	13 — 14	14 — 15	14½	13½
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17½ - 18½	17½— 18½	18½	18
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 —134	129 —134	...	...
30,000	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—30,000	10	*nil*	*nil*	*nil*	15½— 16	15½— 16	15⅝	15½
20,000	Do. do. do. 6% Pref., 40,001—60,000	10	6 %	6 %	6 %	15⅝— 16½	15⅝— 16½	16½	16
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...	...	...	10½ — 11½	11 — 12	11⅝	11½
10,000	Do. do. 7 % Cum. Pref.	5	...	...	...	11½ — 12	11½ — 12	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000	10	4 %	5 %	...	20 — 21	20 — 21	20 1/16	20½
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem.	10	...	...	...	19½ — 20½	19½ — 20½	20⅛	...
220,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	117 — 121	117 —121	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	2½%	4 %	6 %	19 — 20	19 — 20	19⅞	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 181-20,000	5	7½%	10½%	14½ %	18½ - 19½	18½ — 19½	19¼	19
20,000	Do. do. 7 % Pref., 20,001 to 40,000	5	7 %	7 %	7 %	10 — 11	10 — 11	...	...
50,000	Do. do. 4 % Deb. stock Red.	Stock	...	...	4 %	107 —110	107 —110	...	...
43,341	South London Electricity Supply, Ord., £9 paid	5	...	...	...	2⅞— 3⅛	2⅞— 3⅛	2 15/16	...
79,900	Western Electric Supply Corp., Ord., 101 to 80,000	5	7 %	9 %	12 %	18 - 19	17½ — 18½xd	18½	17⅝

* Subject to Founder's Shares.

‡ Unless otherwise stated all shares are fully paid.

† Quotations on Liverpool Stock Exchange.

‖ Dividends paid in deferred share warrants, profits being used as capit

Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, Feb. 23rd.	Closing Quotation March 2nd.	Business done during week ended Mar. 2nd, 1898. Highest.	Lowest.
30,000	British Electric Traction	10	...	...	...	17½ — 17⅝	16½ — 17	17½	16½
90,000	Brush Elect. Engng. Co., Ord., 1 to 90,000...	3	...	...	...	2 — 2¼	2 — 2¼	2 1/16	2
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	...	...	2¼ — 2⅜	2¼ — 2⅜	2⅜	2¼
125,000£	Do. do. 4½ % Perp. Deb. Stock.	Stock	...	...	...	109 —113	110 —114 xd	...	...
50,000	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	102 —105	102 —105	...	...
19,126	Central London Railway, Ord. Shares	10	...	...	...	10½ — 11	10½ — 11	10 15/16	10⅝
143,106	Do. do. do. £6 paid	10	...	...	...	6½ — 7	6½ — 7	6⅞	6⅝
58,830	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1½ — 2	1½ — 2	1 15/16	...
61,777	Do. do. Def. do. £5 pd. ...	...	...	...	...	4⅜ — 5	4⅜ — 5⅛	...	...
630,000£	City and South London Railway	Stock	1 3/16%	1 3/16%	1⅞ %	66 — 68	67 — 69	68⅝	65⅛
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	nil	...	...	2¼ — 2⅝	2¼ — 2⅝	...	...
99,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 99,261	5	5 %	5⅛%	...	2½ — 3	2½ — 3	...	...
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5⅛%	...	4 — 5	4 — 5	4⅜	...
194,023	Do. do. do. 4% Deb. stock Red. ...	100	...	...	...	.....	103 —105	104½	...
110,000	Electric Construction, Ltd., 1 to 110,000	3	5 %	6 %	...	2⅝ — 2⅞	2⅝ — 2⅞	2 15/16	2 11/16
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ...	3	7 %	7 %	...	3⅛ — 3⅜	3⅛ — 3⅜	...	...
91,195	Elmore's Patent Cop. Depos., Ltd., 1 to 70,000	2	...	...	...	⅛ — ¼	⅛ — ¼	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	...	...	...	⅛ — ¼	⅛ — ¼	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	...	...	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	8 %	10 %	12 %	22½ — 23½	23 — 24	23⅝	23 3/16
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	19 — 20	19 — 20	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½%	112 —117	110 —115 xd	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	22 — 23	21½ — 22½xd	22½	21⅞
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	103 —107	104 —108	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2½%	2½%	3½ %	10⅛ — 10⅜	10⅛ — 10⅞	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15½ — 16½	15½ — 16½	...	...
27,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	15 %	15 %	39 — 42	39 — 41	39½	38½
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
54,000£	Waterloo and City Railway, Nos. 1 to 54,000	10	...	...	...	13⅜ — 14½	13⅜ — 14½	14⅛	13⅞

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1893—6%; 1891—7 9/10; 1890—8%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

* Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 11.

Electric Construction Corporation, 5 % Debentures, 106 –108.

House-to-House Company, 4½% Debentures of £100, 106 –109.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 16½—17½xd; 1st Preference Cumulative 6 %, £5 (fully paid), 8½—9. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 4½—4⅝.

* T. Parker, Ltd., £10 (fully paid), 13⅜—14½.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½xd. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (October 14th, 1897).

THE KELVIN QUADRANT ELECTROMETER AS A WATTMETER AND VOLTMETER.

By ERNEST WILSON.

Communicated by Dr. J. Hopkinson, F.R.S., to the Royal Society. Received January 11th—Read January 27th, 1898.

During the past seven years the author has had continued experience with the Kelvin quadrant electrometer, both in connection with scientific research and the training of electrical engineering students in the Siemens Laboratory, King's College, London. This paper embodies a good deal of the experience which he has gained with the instrument, and he has been fortunate in that two of these instruments were available. The numbers of the instruments are 71 and 184. The writer was therefore able to test the one as a wattmeter, using the other for the purpose of investigating the instantaneous rate at which work was being done by alternate currents. The instrument used as a wattmeter (No. 184) is of comparatively recent construction, and differs from the other principally in the omission of the guard tube in the immediate vicinity of the needle surrounding a portion of the needle axis, and the wire connecting the needle to the acid inside the jar. The induction plate employed in the old form is done away with, and the terminals are permanently fixed to the quadrants in this new instrument, otherwise, so far as the author can see, they are identical. These instruments belong to Dr. J. Hopkinson, F.R.S., the old form being the same that he has used for many years, and in connection with which he read a paper before the Physical Society on March 14th, 1885.*

Verification of Clerk Maxwell's Formula.

In the paper just alluded to, it is shown that the sensibility of the instrument (No. 71) increased with the charge on the needle up to a certain point, and that for further increase of the charge on the needle the sensibility diminished. The complete explanation of this is not given, and the author believes Professors Ayrton and Perry were the first to point out that this effect is due to the portion of the guard tube in the immediate neighbourhood of the needle.

* See *Philosophical Magazine*, April, 1885.

To test this point in the new instrument a Kelvin vertical electrostatic voltmeter was placed across the needle and case, and a constant electromotive force applied to the quadrants, one pair being put to the case. The jar was then charged by sparks from an electrophorus, and readings taken on the voltmeter and electrometer scale. The charge was continually increased until disruption occurred between the needle and the lantern which supports the idiostatic gauge. Up to about 2,450 volts on the needle the sensibility increased, and so far as the author could see the needle was further deflected as the charge was increased up to the point of disruption, the spot of light being then off the scale. No great care was taken with this experiment, since it was only carried out for the purpose of ascertaining if diminished sensibility could be obtained with further increased charge. The results are given in fig. 1. In Clerk Maxwell's "Electricity and Magnetism," Vol. 1, p. 273, edition 1873, it is shown that the deflection of the needle of a quadrant electrometer should vary as $(A - B)\left(C - \frac{A + B}{2}\right)$, where C is the potential of the needle, and A and B the potentials of the two pairs of quadrants. In fig. 1 the E.M.F. between the quadrants was less

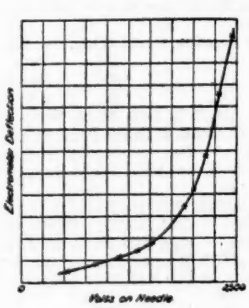


Fig. 1.

than 1 volt, and was constant. By the formula the quotient C/θ should in this case be constant, where θ is the observed deflection.

It varies in arbitrary units from 0·55 to 0·11 as the value of C varies from about 550 to 2,450 volts. This is working the instrument far beyond the range for which it is intended, since when the gauge is in proper adjustment the value of C is only about 550 volts.

In the following experiment the highest E.M.F. employed is 115 volts, and since a square root of mean square value equal to 100 volts was the maximum potential difference about to be used by the author in a certain series of experiments upon alternate current watt-hour meters, it was necessary to see that within this range of potential the formula above given is verified. The instrument was connected as before with one pair of quadrants to the case, the other pair being insulated and the electromotive forces applied to the quadrants, as also to the needle were supplied by storage cells, and accurately measured by Poggendorff's method, the standard of comparison being Clark's cell. The results are given in Table I.

Table I.

Observed deflection θ	A + B volts.	C volts.	$\left(C - \frac{A+B}{2}\right)(A+B).$ / θ
+ 106	57·5	20·7	436
− 140	58·6	3·5	427
− 331	53·3	5·4	431
− 552	52·7	71·6	432
− 773	51·5	91·0	434
− 551	32·5	89·7	433
− 268	14·2	89·7	438
− 352	14·1	115·0	432
− 729	32·3	114·0	434
− 726	48·5	88·9	432
− 427	60·6	60·7	431
− 338	83·9	60·7	427
− 110	113·0	60·7	432
+ 636	113·0	32·2	439
+ 957	113·0	18·1	439
			433 mean

The instrument in the above experiment was mounted on a slate base in the upstairs room of the Siemens Laboratory. The spot of light when working on this base with this instrument is never perfectly steady, and this may account for the errors observed in Table I.

Method of Test.

Fig. 2 gives a diagram of connections showing how the electrometer was used as a wattmeter for alternate currents, and how it was tested when being so used. In the formula

$$\theta = \lambda(A - B)\left(C - \frac{A+B}{2}\right),$$

where λ is a constant, it follows that if A and B are in phase with one another and with the alternate current, and have the same wave form as the alternate current; and if C is in phase with the potential

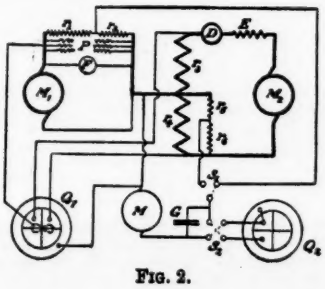


Fig. 2.

difference between two points of the circuit where the power is to be measured, and has the same wave form, A must be equal and opposite in sign to B, since the instantaneous rate at which work is done on or by the circuit must be proportional to A C or B C.

In the Siemens Laboratory there are two alternate current machines* coupled together in such manner that any desired phase difference between their armatures can be obtained. In fig. 2, M_1 and M_2 represent the armatures of these machines. On the shaft of one of these alternators is fixed a revolving contact maker, M, which makes contact between two brushes once in a period, that is, six times in a revolution of the alternator since there are 12 poles. It consists of a gunmetal disc keyed to the shaft of the alternator, and carrying two rings, one of ebonite and the other of gunmetal insulated from the disc by means of the ebonite ring. Into the ebonite ring are inserted six contact making strips of gunmetal $\frac{1}{16}$th of an inch thick, equally spaced out on the circumference and soldered into the gunmetal ring. An insulated copper brush bears on the gunmetal ring, and an insulated steel brush bears on the surface of the ebonite ring, touching each of the contact making strips as the contact maker revolves. The epoch at which such contact is made by the small steel brush can be varied and observed by means of a pointer moving over a fixed circle divided into 360 equal parts. The diameter of this revolving contact maker is 13 inches.

Q_1 is the No. 184 electrometer used as a wattmeter.

Q_2 is the No. 71 electrometer used in connection with the revolving contact maker, M, for the purpose of determining the instantaneous values of the current and potential difference.

D is a Kelvin balance or Siemens electro-dynamometer for the measurement of current; E is the thick wire circuit or circuits of the watt-hour meters being tested; F is a Kelvin multi-cellular voltmeter; r_1, r_2 are non-inductive resistances of comparatively large value for the purpose of reducing the potential difference applied to the electrometer, Q_2, when measuring potential difference, C; the pressure circuits, P, of the watt-hour meters, are placed across $r_1 + r_2$; r_3, r_4 are made up of a manganin strip 50·8 mm. wide and 0·4 mm. thick; $r_3 = r_4 = 0{\cdot}2275$ ohms at about 10° C.; r_5, r_6 are non-inductive resistances of considerable magnitude for reducing the potential difference applied to Q_2 when necessary. The junction between r_3 and r_4 is connected to the case of Q_1; the quadrants of this instrument are connected respectively to the extreme ends of r_3, r_4; whilst the needle of the electrometer is connected to the other pole of M_1. In connection with Q_2, s_1 is a two-way switch for observing potentials across r_3 or r_4; s_2 is the ordinary switch supplied with the electrometer which short circuits the quadrants when moved to its central position, and in its two other positions reverses the charge on the quadrants; G is a condenser, which can be varied from 0·001 to 1 microfarad, its capacity being one microfarad during the experiments, the results of which are given in Table II.

Before giving the results of the experiments, it is well to explain the method adopted of treating the curves for the purpose of arriving at the average watts due to the alternate current, the relation between which and the deflection of the electrometer used as a wattmeter it is desired to find. It is also necessary to examine the limits of accuracy obtainable by this method. In any one experiment the frequency employed is kept constant as nearly as possible; the phase difference between current and potential is adjusted to any desired value, and the amplitude of these quantities is kept constant by observing their square root of mean square values on the instruments, D and F. The revolving contact maker, M, is then set to different positions of the phase, the number employed being at least ten equal divisions to the half period, and for each position, readings taken on the electrometer, Q_2, when the switch, s_1, is in each of its two positions. If the deflections so obtained be plotted in terms of the position of the revolving contact maker, M, the forms of the two curves are those due to the instantaneous values of the potential difference applied to the needle of the electrometer, Q_1, and the current which gives the form of potential difference applied to the quadrants of Q_1. By multiplying each of these deflections together, and by a suitable constant involving the square of the sensibility of Q_2, and the resistances, r_1, r_2; r_3 or r_4; r_5, r_6, the instantaneous rate at which work is being done by the alternate current can be inferred in watts. The average of these over a half period gives the average rate, and this can be obtained by plotting the instantaneous product and taking the area with a planimeter, or the average of the algebraic sum during a half period can be taken. The author found the latter method agreed so well with the former when the number of intervals at which observations are taken is ten, that he has adopted it in this paper, that is to say, the two electrometer deflections for a given position of M are multiplied together, the average of these taken over half a period, and such average multiplied by a constant to reduce to watts.

The best way, perhaps, to test the limits of accuracy is to adjust current and potential until they are exactly in phase. The voltmeter, F, and amperemeter, D, give the square root of mean square values, and the product of these should agree with the average results obtained from the curves. The time required to take one set of observations is generally about 20 minutes, during this time an average for volts, amperes, and frequency is taken. The author finds from experience that if care be taken an agreement between the results got from the curves, and from the product of volts and amperes, can be obtained to within 1 or 2 per cent. It must be remembered that for each position of the contact maker, *four* observations on the electrometer (Q_2) scale have to be obtained; that is, two for potential and two for current corresponding to the two positions of s_2 for each position of s_1, the difference in each case giving the net double deflection. This method is best, as it eliminates any zero error there may be. In working the electrometer, Q_2, a wooden tapper or mallet is employed, since in every electrometer there must be viscosity due to the fluid, and by gently tapping the slate base for each deflection very consistent results can be obtained. This viscosity is greater in winter, and it is advisable to keep the instrument in a warm room, although with this method of tapping the author does not find this necessary. The greatest trouble in the use of the electrometer undoubtedly arises from dust settling on the surface of the acid in the jar, thereby making the angular movement of the wire hanging from the needle smaller than it would be if such brake action did not exist. This takes place when the acid in the jar is old, and if the surface be agitated by blowing through a glass tube near where the wire dips into the acid it can be to a great extent remedied. Whatever the state of the acid the author finds he gets the most consistent results by gentle tapping. The electrometer, Q_1, is not so sensitive as the old form Q_2, and the effect due to the acid in it has not given so much trouble. The sensibility of Q_2 when the idiostatic gauge is adjusted is such that one Clark cell gives a deflection from zero of 10½ inches on a scale 12 feet from the mirror. The potential of the needle is in this case about 350 volts.

(To be continued.)

* A full description of these machines is given in the *Phil. Trans. Roy. Soc.*, Vol. 187 (1896), A. p. 231.

INSTITUTION OF ELECTRICAL ENGINEERS.

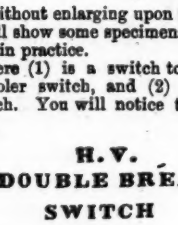
On the Manufacture of Lamps and other Apparatus for 200-Volt Circuits. By G. Binswanger Byng, Member. (Paper read February 24th, 1897.)

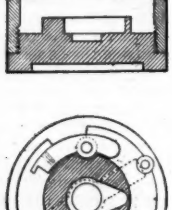
(*Continued from page 272.*)

Without enlarging upon the subject of switches to an undue extent, I will show some specimens of different types I find to be satisfactory in practice.

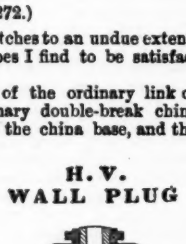
Here (1) is a switch to take the place of the ordinary link or tumbler switch, and (2) here is an ordinary double-break china switch. You will notice the formation of the china base, and the

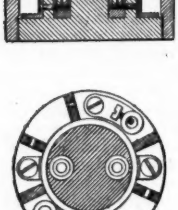
H.V. DOUBLE BREAK SWITCH





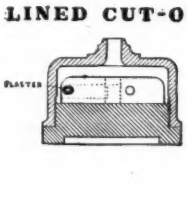
H.V. WALL PLUG

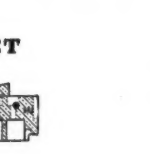




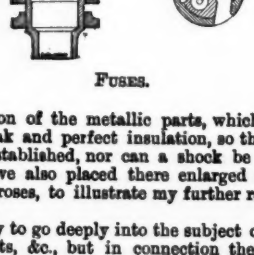
H.V. CEILING ROSE

H.V. CEILING ROSE LINED CUT-OUT





H.V. KEY SOCKET



Fuses.

separation and action of the metallic parts, which are arranged to produce a long break and perfect insulation, so that an arc cannot be maintained if established, nor can a shock be communicated to the operator. I have also placed there enlarged drawings of wall sockets and ceiling roses, to illustrate my further remarks under this heading.

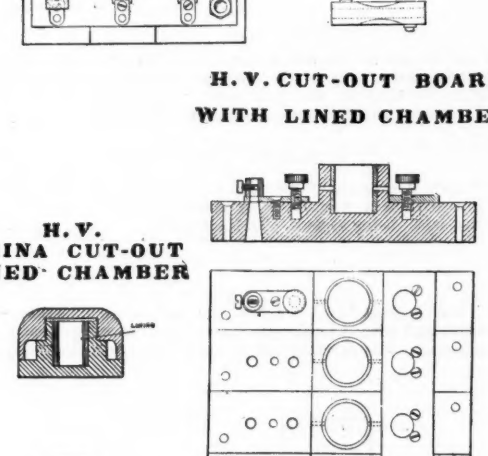
It is not necessary to go deeply into the subject of fixtures such as electroliers, pendants, &c., but in connection therewith I wish to refer to the question whether it is advisable to recommend the use of two or more low-voltage lamps in series on a 200-volt circuit. Within my own experience, I know of several installations fitted originally with 200-volt lamps that have, by reason of greater expense for current, and an inferior light, been re-wired for two 100 lamps in series, with satisfactory results. It is within the province of manufacturers to materially assist wiremen by designing fittings specially adapted to series wiring, such as series holders, ball fittings, brackets, or electroliers with arms in multiples of two, and such a practice might be extended with advantage to many other details.

The question of fuses for higher voltage requires more careful investigation, and would repay thorough discussion. Central station engineers agree to differ upon the various points of efficiency, as evidenced by the different rules issued for our guidance. Some lay stress upon increasing the length of fuse wires, others insist upon ventilation holes, and in some cases the height of covers are to be increased. But there is no unanimity between them, and none of these rules, in my opinion, indicate the right direction.

I have made some extensive experiments, and believe that the results are of interest to the profession generally.

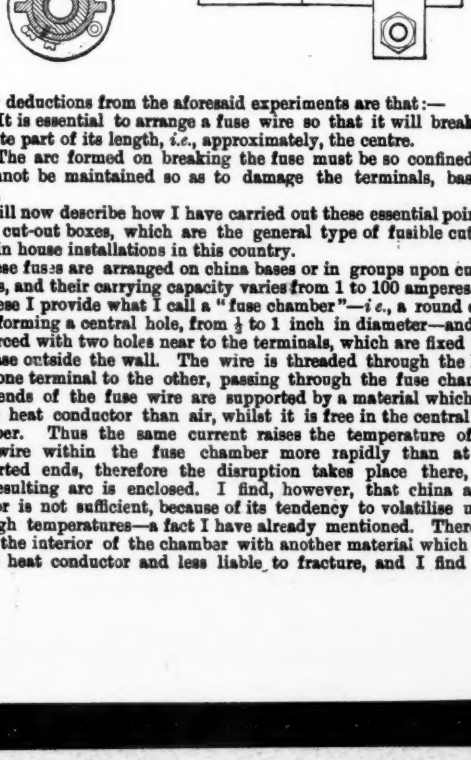
When a circuit is opened by the disruption of a fuse, the combined metallic vapours and hot air produced by the high temperature of the resulting arc may extend and maintain it so as to bridge over the terminals which, melting and becoming volatilised, feed the arc, and rapidly increase the temperature. I find, in practice, that under these conditions the china base supporting the fuse and terminals is easily volatilised also, and not only contributes towards the maintenance of the arc, but is ruptured as if by explosion, tending to set fire to any inflammable surroundings. This rupture has hitherto, I believe, erroneously been attributed to the expansion of air confined by the cover, hence the ventilation holes, which, according to my opinion, are useless. The same experiments tend to prove the fallacy of using a long fuse wire, with the concomitant disadvantages of finding space for it, and also difficulty in renewal; and I feel sure that full efficiency may be attained with a short fuse.

H.V. CUT OUT BOARD SPRING CLIPS FOR HOLLOW CHINA FUSE HOLDERS



H.V. CUT-OUT BOARD WITH LINED CHAMBERS

H.V. CHINA CUT-OUT LINED CHAMBER



My deductions from the aforesaid experiments are that:—

1. It is essential to arrange a fuse wire so that it will break at a definite part of its length, *i.e.*, approximately, the centre.

2. The arc formed on breaking the fuse must be so confined that it cannot be maintained so as to damage the terminals, base, or cover.

I will now describe how I have carried out these essential points in china cut-out boxes, which are the general type of fusible cut-outs used in house installations in this country.

These fuses are arranged on china bases or in groups upon cut-out boards, and their carrying capacity varies from 1 to 100 amperes. In all these I provide what I call a "fuse chamber"—*i.e.*, a round china wall forming a central hole, from ½ to 1 inch in diameter—and this is pierced with two holes near to the terminals, which are fixed upon the base outside the wall. The wire is threaded through the holes from one terminal to the other, passing through the fuse chamber. Both ends of the fuse wire are supported by a material which is a better heat conductor than air, whilst it is free in the central fuse chamber. Thus the same current raises the temperature of the fuse wire within the fuse chamber more rapidly than at the supported ends, therefore the disruption takes place there, and the resulting arc is enclosed. I find, however, that china as an isolator is not sufficient, because of its tendency to volatilise under the high temperatures—a fact I have already mentioned. Therefore I line the interior of the chamber with another material which is a better heat conductor and less liable to fracture, and I find that

ordinary plaster of Paris is most convenient for this purpose, although several other substances may be equally efficient.

Fuses constructed on this principle require but a short length of wire, and are perfectly safe on high voltages, and the general appearance and size does not differ to any great extent from those now in common use. The principle once established of surrounding part of the length of fuse wire with a substance that is a better conductor of heat than air, we can easily construct any other type of fuse upon the same principle.

Fuse wires enclosed in glass tubes filled with plaster or cement, but with a free central space for fusion, for instance, fulfil the same conditions.

I find that such fuses have been patented by Mr. Mordey in 1890. The mere fact of enclosing a fusible wire in a non-conducting refractory filling would not fulfil the essential functions of a perfect fuse as I have described, without a clear space at or about the centre for disruption. Mr. Mordey describes such a space in his specification, but it is for the purpose of observation only, and it is not clear, from the tenor of the specification, that the inventor had this purpose of the localisation of fusion in mind. Mr. Miller, of Kensington, has also altered the ordinary Edison fuse by substituting thin copper wire, and partly filling the centre with asbestos fibre. So far as localising the point of disruption and confining the arc, this fuse acts very well, although copper or alloyed fuses are not perfect under any circumstances, by reason of the maintenance of a dull red heat under normal load.

Arc Lamps.

Coming, now, to the subject of arc lamps in relation to the higher pressure, I do not see that, with alternating currents, the increased potential materially affects the consumer. The practice may bring a single-parallel system into vogue, with economy coils—an alteration which will, in my belief, increase the commercial efficiency of alternating arcs. But the disadvantages are apparent in the case of a continuous current circuit. For instance, in small installations of one or two lamps on the 100-volt circuit, these must be doubled on the 200-volt circuit, or useless resistances interposed. To equalise the conditions it has been proposed to substitute low current lamps, say, four 5-ampere instead of two 10-ampere lamps.

As this substitute has been advocated by one of the foremost central station engineers, and many others will possibly follow him, it may be useful and not out of place to prove that both in theory and practice low current arc lamps are deficient in points of economy and efficiency.

It is generally accepted that the current density of an arc is independent of its size; assuming this as correct, the area of an arc must be proportional to the current, and the cooling surface proportional to its diameter. This is the case with the cooling surface of the carbons, if these are used of areas proportional to the current taken by the lamp. Thus the cooling effect of the atmosphere will have a direct relation to the diameter of the arc and to the square root of the current. Therefore, for illumination, large arcs are more efficient than small ones, and the practical arc is attained when the benefit of increasing the number of light centres balances the inefficiency of small arcs. This gives, in practice, an arc of about 10 amperes.

Small arcs worked under same conditions are more unsteady than large ones, which is due to the fact that with an arc of a given length the E.M.F. decreases as the current increases. An experiment in which a fixed length of arc at 5 amperes and 44 volts was suddenly increased from 5 amperes showed—

Normal	5 amperes	...	...	44 volts.
Sudden increase from	5 to 6 amperes		...	40·5 „
„ „	5 „ 7 „		...	38·5 „
„ „	5 „ 8 „		...	37·2 „
„ „	5 „ 9 „		...	36 „
„ „	5 „ 10 „		...	35·2 „

So an arc, or series of arcs, with a total voltage approximating to the E.M.F. of the circuit is unstable and fluctuating—probably due to the disproportionate variations of the cooling surface, coupled with the decreased resistance of carbon at higher temperatures. If the arc flares, the current will increase, unless there is sufficient resistance in series to reduce the voltage across the arc at a greater rate than the above figures show. Certainly the mechanism tends to lengthen the arc, but to no advantage because the movement continues until the current decreases to the normal value, and the acceleration would extinguish the arc unless an interposed resistance allowed of a rapid increase of the voltage across the arc. Such a resistance is necessary to compensate the "negative resistance" of the arc, which may be more appropriately termed "decreased cooling surface per ampere." An additional resistance in series is necessary to ensure steadiness. It follows, therefore, that 5-ampere lamps must be worked on a higher E.M.F. or "pumping" will ensue.

(To be continued.)

TEST OF THE CHICAGO STORAGE BATTERY ROAD.*

The carefully conducted test of the plant of the Chicago Electric Traction Company furnishes the most valuable data at present obtainable regarding the application of the storage battery to street railway service. The vital question of the cost of battery maintenance is still an open one, yet the batteries tested have shown a better record than any of their predecessors. The results of the tests make a good average, showing just about what might be expected from a trolley road operating under the same conditions.

It may be well to preface the test with a sketch of the history of the company and a description of the equipment. The conception of the road was for the purpose of booming real estate in the south-western portion of the city. The company was chartered early in 1894 with a capital stock of $2,500,000, and almost from the beginning it has laboured under financial difficulties. In 1895 a majority of the bonds were placed with parties interested in the manufacture of storage batteries with the understanding that battery cars should be run. The company owned six franchises, covering 36 miles of streets, but nearly all the tributary territory is very sparsely settled. In a short time the company became insolvent, and in January, 1896, G. Herbert Condict was appointed receiver. Under foreclosure proceedings the road was sold at public auction October 12th, 1897, to J. S. Bache for $260,000. E. R. Gilbert was appointed general manager of the company. Some idea of the traffic of the road is given by a statement of the receipts and expenditures in the receiver's report:—

	Passengers and miscellaneous.	Operating expenses.
January to June	$4,972	$9,188
June	2,482	3,224
July	6,045	4,609
August	7,045	6,048
September...	6,347	6,584
October 1 to 12	2,254	2,880

The main line extends from the northern terminus at South Park Avenue and 63rd Street, the intersection with the Alley L, south to Englewood, Washington Heights and Blue Island, and a branch runs from Morgan Avenue West through Morgan Park. The line passes several summer resorts and three cemeteries; a large summer traffic results from the former, and for the latter a car, specially designed for funerals, is in operation. On the Morgan Park line a grade of 9·3 per cent. is encountered for a distance of 371 feet on Prospect Avenue. This gradient was insurmountable for a car equipped with one 50-H.P. motor geared to one axle only. A counter weight system was installed which is almost a duplicate of the one in Providence, R. I., designed by M. H. Bronsdon and J. P. F. Kuhlman, and described in the *Review*, April, 1896. There are 23 miles of track now laid, of which 19 miles are double.

After the decision to use storage batteries was reached, B. J. Arnold and J. H. Vail were employed as engineers to plan the entire system. All the designs follow the most approved line of engineering practice, and no pains were spared to make it a model of its kind. From the boilers to the batteries everything was designed with a view to economy and convenience. Perhaps this is the first time that the storage battery has been given an honest and prolonged trial in this country, and if it is capable of successful operation in street railway service it should be demonstrated in this system.

The track, which was constructed by C. E. Loss & Co., is the very best, for this was essential to long life for the battery plates. Johnson 7-inch girder rails, weighing 80 lbs., and resting on tie plates, are joined by 6 bolt fish plates with tie rods at every joint. Oak ties, 8 feet long, are placed 2 feet between centres, and rest on 6 inches of gravel ballast. The construction, with the absence of trolley wires and rail bonds, appears as though it were intended for steam traffic.

The power station is worthy of note, for it is certainly different in many respects from any other railway station. It is not necessary to locate the power house at the "centre of gravity" of the system to get the most economical current distribution, so a site was selected at 88th Street and Vincennes Avenue, convenient to the Rock Island railroad, and where land is cheap and transportation for fuel good. Car tracks run through the loggia, and above this are the offices, locker room, shower baths, toilet rooms, and waiting rooms for the employés.

Unlike street railway stations in general, the dynamos are not all of the same voltage, for it is necessary to have three circuits of different potential to charge the batteries properly. Four six-pole, 190 kw., shunt wound Walker generators, with a variable voltage between 160 and 190, were installed. This is the ultimate dynamo capacity of the station, the fourth machine being held in reserve. The dynamos are direct connected to two 250-H.P. Willans engines, the kind so generally used in the electric power stations of Great Britain. These two engines are at either end of the room, and a third one, of 500 H.P., will be put in the centre. To give the most flexible arrangement, the Arnold system of power station construction was adopted. A solid shaft with couplings extends from one engine to the other. The armatures of the generators are fixed to quills, which are free to rotate about the solid shaft. This makes a very complete and compact engine generator installation, a 1,000 H.P. plant occupying a floor space only 12 feet × 56 feet. Each engine has two sets of cylinders, the cranks being opposite to one another. The steam, entering the high pressure cylinder, from the steam chest, expands through the hollow piston rod into the receiver space below, ready to act on the following piston. An air cushion takes up the momentum of the moving parts and permits a speed of 380 r.p.m., without excessive noise or vibration. The speed is regulated by a throttle valve in the steam pipe controlled by a centrifugal shaft governor.

Just to the rear of the power units is the white marble switchboard, consisting of five panels, one for each generator and the fifth for the motor switches. There are four bus bars, the three lower ones being for the high, medium, and low voltages, and the top one

* *Street Railway Review.*

the common negative bar. Each panel has two switches, one for the negative lead of the generator after it has passed through a recording ammeter and circuit breaker, and the other switch can be turned through a semi-circle making connection with any of the three positive bus bars. Weston illuminated dial ammeter and voltmeter and a resistance box for controlling the voltage are attached to each generator panel. From the motor panel the circuits are controlled which run to the two battery transfer cars, the car transfer tables in the basement, to the cooling tower motor and the other motors in the building. By means of the circular switch in the centre of the motor panel, the motor bus bars can be connected to any of the three positive bus bars, or the motors can be operated from the car batteries when the generators are not running. The engine room presents a very attractive appearance, being finished with white marble floors and wainscoting, and visitors' gallery.

The passageway to the boiler room is behind the engines and by the condensers in the basement. There are three 200-H.P. Heine water-tube boilers, with room for three more. Coal is delivered on a side track back of the boiler room, where it is intended to have the fuel transferred direct from the cars to the iron platform in front of the boilers, about 7 feet above the floor. From here it is shovelled into the hoppers of the Roney stokers.

The smoke stack, which is located about 30 feet outside the building, is constructed of steel, is self-supporting, 7 feet in diameter and 150 feet high. It rests on a brick foundation, raising it to 22 feet above the ground. Connection to the boilers is made through an iron flue back and above them and through a brick flue entering the brick base of the stack. A Green fuel economiser, having 192 tubes, is in the brick flue; a by-pass is also provided for service when the economiser is not in use. Adjoining the stack is a Worthington cooling tower, 12 feet in diameter and 30 feet high. The condenser pump delivers the condensed steam and heated injection water to the top of the tower, and here, by means of revolving pipes turned by the pressure of the escaping water, it is sent in sprays over the tops of sewer tile set on end in tiers. During warm weather a large fan, driven by a Siemens-Halske motor, cools the water by evaporation, so that when it collects in the condenser well its temperature is about 80° F. The feed-water pipe taps into the condenser discharge before the pipe reaches the tower.

The supply of feed-water comes from an artesian well and from the city mains, but by the arrangement of the jet condensers and the cooling tower, the amount taken is only sufficient to make up for the waste due to evaporation. The water can be taken through a heater, which receives the exhaust from the auxiliary pumps, and through the economiser into the boiler, or either of the heaters can be cut out if necessary. The economiser not only heats up the water to the boiling point, but also acts as a reservoir with a supply of hot water which increases the duty of the boilers. The steam is supplied to each engine through a 6-inch pipe, having a copper expansion bend, and the engine exhaust is conducted to jet condensers.

The most unique and interesting features of the plant are to be found in the battery room, which is in the basement under the car barn. The car battery consists of 72 cells arranged in 12 rows of six each. These cells each have nine plates, $7\frac{3}{4}$ inches wide and $14\frac{3}{8}$ inches long, five of which are negative of the "Chloride" type and four positive of the "Tudor" or "Manchester" type. The positive plates are $\frac{1}{16}$th inch and the negative $\frac{1}{4}$ inch thick. Each cell, including plates, electrolyte and hard rubber jar, weighs 100 lbs., making the total weight for a tray 7,800 lbs. The plates are connected by electrically welded lead strips in four groups of 18 cells, each group being joined by flexible cables to two large brass plates on the sides of the trays. A loose fitting rubber crate over the top of the batteries prevents the electrolyte from splashing out of the jars.

By means of the three separate generator circuits the batteries can be charged at three different potentials as the counter electromotive force in the battery rises. The discharged battery is first connected to the 160-volt main with a current of 150 amperes flowing. The current decreases as the counter electromotive force increases, and when the current diminishes to 30 amperes, the battery is switched into the 172-volt circuit. The current jumps to 150 amperes, and diminishes again, and then the terminals are transferred to the 176-volt circuit. This operation can be accomplished in about 40 minutes, although a slightly better battery efficiency is shown when the time is longer.

After the batteries are charged the next important step is to get them in the cars expeditiously, and this is accomplished by a travelling carriage which runs along the track in the alley alongside the battery tables. On either end of the carriage is an elevator with rolls on top which are operated by bevel gears. Similar rolls are on the charging tables, which can be coupled to the elevator rolls and the trays automatically shifted. In the middle of the carriage is the operator's platform, with a controller for each of the motors, two of which are for the rolls, one for each elevator and one to run the carriage along the track.

When a discharged battery on a car is to be replaced a charged one is rolled upon one of the elevators and the carriage is run to a position where the vacant elevator is directly beneath the track in the loggia. The car, at the end of each round trip, runs into the correct position, which is determined by the vertical position of a lever the conductor lifts so that the front bumper of the car just touches it. The vacant elevator of the carriage is raised and the discharged battery released from the car by pulling a lever. When it is lowered the carriage is advanced so that the charged battery is beneath the car truck. The battery is elevated, the hooks automatically engaging the cross bars and the brass plates on the sides of the trays making a sliding electrical connection with the spring clips on the car trucks which are the terminals of the controller cables. The entire operation can be performed in 50 seconds, although the customary time is a little over a minute. The carriage then carries the discharged battery to an empty charging table, where it is rolled from the elevator and makes electrical connection with the charging circuit. The battery room, although well ventilated, is filled with the fumes of sulphuric acid. This disagreeable condition could probably be obviated by having hoods over the charging batteries and the fumes conveyed to the stack.

There is provision in the car barn at present for 28 cars, but it will be extended eventually to accommodate 50 cars. The transfer table, operated by an electric motor, runs on a track down the centre of the barn. No special tools or preparations have been made for repairs. Besides the regular equipment of cars, a 3,500-gal. sprinkler is provided for summer and a snow plough for winter.

The motor cars are mounted on Dupont trucks, made by the Johnson Company. Each truck has two bars running across the frame and engaging hooks, formed by bending over four 5-inch channel irons, which pass under the tray. A 50 H.P. Walker motor is suspended on the outside of the car axle. The controllers, made by the Walker Company, had to be of special design for the service, as the low voltage necessitated large currents. There are five points: the first combines four sets of batteries in parallel, giving 36 volts; the second gives 72 volts with the cells in series-parallel; the third puts the batteries in series with resistance; the fourth cuts out the resistance but leaves the batteries in series, and the fifth shunts the motor field with the batteries in series.

During the summer of 1897 over 20 motor cars were operated, often with trailers, and when the winter schedule of nine cars was instituted, Mr. Condict, then general manager of the road, decided to make a complete test of the road and power house to determine the most economical methods of operation. Under the direction of George A. Damon, who was assisted by Prof. Gaylord and a corps of students from the Armour Institute, three complete tests were conducted under actual operating conditions. The following is an abstract of the report of the tests for which we are under obligations to Mr. Condict. We are also indebted to Mr. Damon for courtesies extended.

Test of Power Plant.

The equipment of the power house has already been described. In preparing for the tests all proper precautions were taken to secure accurate data. The apparatus used was carefully calibrated. The water was measured by means of three tanks just before it entered the feed pumps. The steam used by the stoker engine, by the economiser engine, by the calorimeters, by the feed pump, and by the air pump was condensed and carefully measured. The blow-off from the boilers and other unused piping was opened up to guard against the water escaping through unknown leaks. All water not accounted for by the auxiliaries was charged against the engines, with the exception of a liberal allowance for leakage in the live-steam line.

The first test was with the plant running with two boilers, two engines and three generators. The second test was with practically the same load carried by one boiler, one engine and two generators, while the last test was made under practically the same conditions as the second test, with the exception that the three-voltage method of charging the batteries was abandoned. In this test but one generator was used, and the batteries were charged in successive sets, all at a common potential, the voltage being raised as the batteries became charged in such a way that the load upon the generator was kept nearly constant.

The coal used was from Fairmount, W. Va., and cost, delivered at the power house, $1.90 per ton. An average of five determinations of its calorific value by the Berthier method gave 10,145 British thermal units per pound. The average of six analyses gives the following result:—

Moisture	6·326	per cent.
Volatiles and combustibles	32·903	,,
Fixed carbon	48·126	,,
Sulphur	2·700	,,
Ash	10·030	,,

Card No. 7.—Taken 3.15 p.m. on November 26th, 1897.

	M.E.P.	Horse-power.	
High-pressure cylinder, North Line ...	59·85	31·14	...
do. South Line ...	71·7	...	37·16
Intermediate receiver, North Line ...	15·6	6·96	...
do. South Line ...	15·8	...	7·04
Intermediate cylinder, North Line ...	24·8	28·19	...
do. South Line .	26·7	...	30·55
Low-pressure receiver, North Line ...	5·85	6·38	...
do. South Line ...	5·73	...	6·25
Low-pressure cylinder, North Line ...	8·18	24·90	...
do. South Line ...	8·81	...	26·81
Transfer chamber, North Line ...	4·92	14·88	...
do. South Line ...	4·12	...	12·46
Horse-power, North Line ...	...	112·45	...
do. South Line ...	...	...	120·27
Total horse-power	...	232·72	...

Revolutions per minute	373·3
Gauge pressure	182·0
Vacuum	25·5
Kilowatt output	139·4
Electrical horse-power	186·9
Efficiency	80 %

Eight indicators were necessary to obtain the horse-power developed by each engine. A typical record of one set of cards is shown in the table.

Cards were taken every half hour during each test. The results of the cards taken during the test of November 26th are shown in the following table:—

Time.	Card.	I.H.P.	E.H.P.	Efficiency per cent.
After test.	1	25 08	...	Friction.
After test.	2	32 36	...	Friction.
After test.	3	32·36	...	Friction.
3.15 p.m.	7	232·72	186 9	79 93
3.45 „	8	226 58	177·4	78 29
4.45 „	9	214·25	168 4	78·6
5.15 „	10	217 5	171·4	78 85
5 45 „	11	218 6	172·2	78 77
6.15 „	12	222 12	176·9	79·64
6.45 „	13	209 83	164·4	78·35
7.15 „	14	215 56	176 4	81·83
7.45 „	15	224 66	182·1	81·05
8 15 „	16	227·49	180·3	79 25
8.45 „	17	208 64	162·5	77 88
9 15 „	18	202 15	156 8	77 56
11 15 „	21	246 24	196·5	79·8
11.45 „	22	237 ·8	190·3	80·

Average indicated horse-power, 217.
Average electrical horse-power, 172.
Average all-day efficiency, 79 3 per cent.

(To be continued.)

THE MAGNETIC PROPERTIES OF ALMOST PURE IRON.

By ERNEST WILSON.

Communicated by Dr. J. Hopkinson, F.R.S., to the Royal Society.

Received January 11th. Read January 27th, 1898.

One of the two rings of almost pure iron supplied by Colonel Dyer, of the Elswick Works, to Sir Frederick Abel, K.C.B., F.R.S., by whom they were sent to Dr. John Hopkinson, F.R.S., has already formed the subject of a communication,* and is herein referred to as Pure Iron I. As this pure iron has not been directly tested for dissipation of energy due to magnetic hysteresis, and the second ring was available, the author thought it would be interesting to examine its magnetic properties: it is referred to as Pure Iron II. The substances other than iron in this specimen are stated to be—

Carbon.	Silicon.	Phosphorus.	Sulphur.	Manganese.
Trace.	Trace.	None.	0·013.	0·1.

This ring has an internal diameter of 3·2 cm., an external diameter of 4·5 cm., a depth of 2·6 cm., and is wound with 61 turns for the secondary coil next the iron, and 49 turns for the primary or magnetising coils. The method of test† employs a ballistic galvanometer, and is that in use in the Siemens Laboratory, King's College, London, where the present experiments were carried out. The currents in the primary circuit were supplied by storage cells, and measured by balancing the potential difference due to such currents in a standard resistance against a Clark's cell. The current meter in the circuit was only used for convenience of adjustment.

Quoting from the communication above referred to, Pure Iron I. gives the following induction curve at atmospheric temperature:—

B....	34	118	467	2,700	7,060	10,980	14,160	15,590	16,570	17,120	17,440
H....	0·15	0·38	0·60	1·06	2·11	3·77	7·48	13·36	23·25	33·65	44·66

Pure Iron II. has been tested under two conditions: (*a*) as received, and (*b*) after careful annealing. The results are given in Table I, which also contains the results obtained by Prof. Ewing from a sample of transformer plate rolled from Swedish iron.‡ The figures of Prof. Ewing relating to magnetic hysteresis are exceptionally low, and although annealing has considerably improved the Pure Iron II., it is still slightly inferior to the transformer plate. On the other hand, the permeability μ of this pure iron after annealing is exceptionally high, having a value 5,490 for B = 9,000. The coercive force for maximum B = 15,270 is 1·13 C.G.S. units.

* *Roy. Soc. Proc.*, Vol. 52, p. 228.
† *Ibid*, Vol. 53, p. 352.
‡ *Proceedings Institution of Civil Engineers*, Vol. 126, p. 185.

Table I.

Limits of B in C.G.S. units per square centimetre.	Dissipation of energy by magnetic hysteresis in ergs per cycle per cubic centimetre.					
	Transformer plate rolled from Swedish iron (Ewing).		Pure Iron II. tested as received.		Pure Iron II. tested after annealing.	
		μ.		μ.		μ.
2,000	220	2,560	350	2,000	262	2,500
3,000	410	3,340	500	2,730	460	3,190
4,000	640	3,880	800	3,330	720	3,810
5,000	910	4,230	1,100	3,700	1,010	4,350
6,000	1,200	4,410	1,450	4,138	1,350	4,800
7,000	1,520	4,450	1,760	4,375	1,670	5,380
8,000	1,900	4,330	2,160	4,445	2,020	5,440
9,000	2,310	4,090	2,600	4,615	2,450	5,490
10,000		3,790	3,100	4,545	2,860	5,460
12,000			4,400	4,000		4,900
14,000			5,900	2,641		3,260
15,000				1,415		2,030

The figures in Table I. relating to Pure Iron II. after annealing have been obtained by interpolation from the actual observed data given in Table II. An induction density of 15,270 for H = 9·24 is higher than the author remembers having seen. In fact, for values of H below about 10 or 12 this specimen is exceptionally good, as is shown by the very high permeability.

Table II.

Limits of H.	Limits of B.	$\frac{1}{4\pi}\int H\,dB$.	μ	Coercive force in C.G.S. units.
0·783	1,965	262	2,510	0·50
1·14	4,840	...	4,245	...
1·17	5,150	1,080	4,400	0·73
1·42	7,500	...	5,280	...
1·66	9,100	2,490	5,480	0·90
2·23	11,460	...	5,140	...
2 68	12,500	...	4,660	...
4·74	14,270	...	3,010	...
9·24	15,270	...	1,650	1·13

Apparent Magnetic Instability.

Whilst making the foregoing experiments, the author noticed how great was the apparent magnetic instability in this specimen, and thought it worth to investigate this more closely.

It has already been noticed, and is well known, that if the magnetising force be varied from one maximum value through zero to a value equal, say, to the then coercive force of the material, that tapping the specimen will produce a considerable change of induction; or if the observed kick on a ballistic galvanometer (in circuit with a secondary coil wound on the specimen) due to such change be added to the observed kick when the magnetising force is raised to the opposite maximum, the sum does not equal the whole kick which would be observed if the force were at once varied from the one maximum to the other. During the interval the magnetism appears to continue to settle down, so that the change which lastly takes place is not so great as it would be if such apparent settling down did not occur.

Experiments were made to investigate the effect when the limits of B were (*a*) large and (*b*) small. It is assumed that the instrument gives the true time integral of current.

(*a*) Maximum B = 15,270, coercive force 1·13 C.G.S. units. The maximum force, H, of 9·24 C.G.S. units, was suddenly varied through zero to 1·13, and the secondary circuit kept closed until deflections to the left and right were observed, the periodic time of the galvanometer needle being 10·6 seconds. The scale is graduated from 0 on the left to 1,000 on the right, and the readings taken were 351, 623, giving a difference of 272, corresponding to a change of induction per square centimetre of 12,630 C.G.S. units. When the magnetism had settled down, as was shown by closing the secondary key with no extra resistance in its circuit, and observing no deflection on the ballistic galvanometer, a suitable extra resistance was inserted, and the force suddenly raised to its maximum value, the observed deflections are 362, 627, the difference 265 corresponding to B = 12,350. These results were many times repeated.

The total change of induction produced a deflection 662, 330, the difference 332 corresponding to B = 15,270. We have, therefore, to account for a difference of 5,560, or 18 per cent. of the total change from one maximum to the other. The zero, when the spot of light is perfectly steady, is 495, and we can see that when making the first change from one maximum through zero to force, 1·13 the deflection to the left is 143 as against 128 to the right; whereas, when making the second change, the deflections are 133 to the left and 132 to right. There is evidence here of a change of continuing in the same direction, since the first elongation is greater than the second, and the decrement would only account for about 1 per cent.

This effect was next observed in a slightly different manner. The change of force from one maximum through zero to the then coercive force was effected, and the secondary circuit closed at known intervals of time after such change. The results are given in Table III.

Table III.

Time in seconds ..	0	1	2	3	4	5	6	10
Change of B, 10 cells exciting through extra resistance	13,600	4,030	1,990	927	576	285	175	42
Change of B, 56 cells exciting through extra resistance	13,800	3,690	1,680	944	529	256	...	40

It will be seen from the figures that about 30 per cent. comes out after the first second has elapsed, and that the result is practically the same, whether the charging potential difference be that due to 10 or 56 cells. With a total reversal from one maximum to the other no such effect was observed, the change taking place immediately. Having taken the force from one maximum through zero to a value equal to the then coercive force, the specimen was tapped four times with a piece of wood, and at each stroke it delivered 105, 40, 56, 30 C.G.S. units per square centimetre in the direction of acquirement of magnetism.

(*b*) Maximum B = 3,770, maximum H = 1·003. The force was varied from one maximum through zero to 0·620 and a deflection corresponding to B = 3,620 observed. The figures in Table IV. give the results obtained by closing the secondary circuit at known intervals of time after reversal.

Table IV.

Time in seconds	0	1	2	3	5·
Change of B, five cells exciting through extra resistance ...	3,620	536	95	25	10

One would expect the maximum induction to be affected in this case, since it is on the steep part of the curve: the figures obtained are given in Table V.

Table V.

Time in seconds	0	1	2	3	5
Change of B, five cells exciting through extra resistance ...	3,770	796	23	14	6·5

The curve in fig. 1 shows this effect clearly; the points 1, 2, 3, for any force show the observed change of induction density B when the secondary key is raised ½ second, 1 second after reversal, and kept down permanently as in the ordinary way. When observing the deflections for the curve in fig. 1, the five cells used for exciting had placed across their terminals a condenser of 4 microfarads capacity.

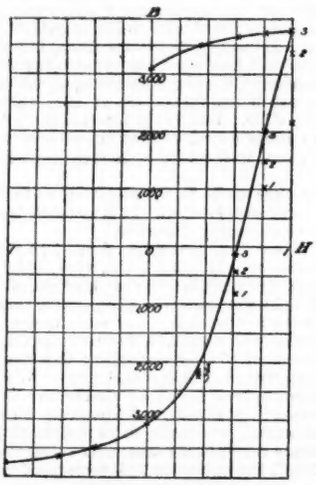


Fig. 1.

We are dealing with a very steep curve in these experiments, that is to say, the rising portion for the large forces is very nearly perpendicular. We observe that it is on the steep portions that these effects have been noticed, and such effects could very easily be produced by a slow change in the magnetising force. Such slow change might arise from the heating of resistances in the circuit, if these be of carbon; this was looked into, and only metal resistances used. The self-induction of the circuit might, if large enough, delay the magnetising current, and produce the effect. We have seen that it is practically the same, whether the applied potential be that due to 10 or 56 cells. In any case the self-induction can be approximately calculated in our case. Take the curve in fig. 1—we see B increases 5,750, whilst H increases 0·6. The total change is 9,860, since the cross sectional area of the specimen is 1·715 sq. cm. H = 0·6 corresponds to a change of 0·117 ampere, and, taking the volt as our unit and the primary turns at 50, we find L = $4{\cdot}21 \times 10^{-2}$, where L is the coefficient of self-induction. If E be the applied potential and R the resistance of the circuit, the current at any time, t, after closing the circuit, can be expressed by $\frac{E}{R}\left(1-\epsilon^{-\frac{R}{L}t}\right)$. For $t = \frac{1}{2}$ second the current has its maximum value within an exceedingly small quantity. But the method of experiment enabled one to test the rapidity with which the current rises to its maximum value. Let a balance be made, say, when the current is such that the force is equal to the coercive force of the material. Now suddenly reverse the force from its maximum through zero to this value. The immediate depression of a key tells at once if the current is still balanced. The current, immediately after reversal, that is to say, within ½ second, had certainly attained its normal value to within 0·3 or 0·4 per cent.

The condenser had no material effect upon the rapidity with which the current attained its maximum value. We can only conclude that the effect is peculiar to the iron itself, and might be influenced by induced currents, since the ring is not subdivided. The subject of propagation of magnetism as affected by induced currents has been dealt with in the case of a magnet having a core 12 inches diameter,* and a magnet having a diameter of 4 inches.† Imagine that the cross section of our pure iron specimen is circular instead of rectangular—it would have a diameter of 14·8 mm. If we assume equal conductivities and magnetic properties, we can infer, roughly, from the 12 and 4-inch magnets, what the effect of induced currents in our specimen would be.

Take the 12-inch magnet. For reversal of maximum H = 2·4 the effects had died away in about 400 seconds. Similar events will happen in the pure iron core, but at times varying as $\left(\frac{14{\cdot}8}{305}\right)^2$: that is, we should expect the effects to have subsided in 0·85 second.

Take the 4-inch magnet. For reversal of magnetism H = 1·7, the effects had subsided in about 40 seconds: $\left(\frac{14{\cdot}8}{101{\cdot}6}\right)^2 \times 40$ gives 0·94 second.

It is, therefore, probable that the induced currents in the Pure Iron II. may have something to do with the effects observed in this paper, although it is difficult to account for such times as five and 10 seconds, unless the molecule itself is considered. This effect has been observed in laminated specimens.

The difficulty of working with alternate currents, if the core be subdivided, in order to investigate the effects observed, using the method in the *Proceedings of the Royal Society*, Vol. 53, p. 352, is the necessity for the very accurate control and measurement of the magnetising force. Small variations of this force would at once mask the effects observed. In the paper just mentioned a considerable difference was observed between cyclic curves obtained with the ballistic galvanometer, and by means of alternate currents having frequencies of 72 and 125 per second in the case of a laminated hard steel ring for maximum B = 16,000. On the other hand, no such difference was observed in the case of a laminated soft iron ring when maximum B was 4,000.‡ It would seem from the experiments in this paper that the amplitude of induction would not be so great for high frequency and small induction density, B, and this is of importance in the case of iron cores for transformers. It is worth noting that when working on solid rings with the ballistic galvanometer, induced currents may account for apparent magnetic instability.

Mr. H. H. Hodd has helped me in the experimental part of this paper, and I here wish to tender him my thanks.

A $1,000,000 GUTTA-PERCHA SCHEME.§

The Gutta-Percha Corporation, Limited, with $1,000,000 capital, was "floated" in London in December. The object is to acquire the Sérullas patents for extracting gutta-percha from the leaves of the *Isonandra dichopsis* and other trees of that family.

The London *Financial Times*, not inaptly, headed its notice of the new corporation "Stale Eggs for Sale." Readers of the *India-Rubber World* will remember that, so long ago as 1892, Hippolyte Eugene Sérullas, who had gone to the East Indies at the expense of the French Government to report upon the gutta-percha supply, read before the Société d'Encouragement pour l'Industrie Nationelle, an account of his discovery of a method of extracting pure gutta-percha from leaves and twigs, instead of destroying the trees, as is so common in Borneo. Patents were granted subsequently to Sérullas, in conjunction with Felix E. Hourant, in several countries, and the rights under these patents are involved in the above scheme. In England two patents were granted—No. 11,116 of 1892, and No. 654 of 1896. In the United States there is one patent—No. 575,739. In spite of the publicity of M. Sérullas's idea for so many years, and the fact that the owners of the patents have been ready at all times to realise upon them, the fact that no attempt has been made to work the idea on a commercial scale implies a general lack of confidence in its value.

But Sérullas is not alone in having a method for extracting gutta-percha from leaves. Another Frenchman—Dieudonné Rigole—has been in the field with a patent for this purpose for several years.

* *Journal of Proceedings of Institution of Electrical Engineers*, Vol. 24, Part 116.

† *Phil. Trans.*, Vol. 186, A, pp. 93—121.

‡ See *Electrician*, September 9th, 1892.

§ *India-Rubber World*.

The British issue was No. 4,252 of 1892. The *India-Rubber World* in September, 1893, published a prospectus of the Gutta-Percha Manufacturing Company, with $600,000 capital, to exploit Rigole's method. Nothing coming of this, the Borneo Gutta-Percha Plantation and Produce Company, Limited, with $300,000 capital, was projected, as we reported in May, 1894, but nothing more has been heard of that enterprise.

By the way, the new Gutta-Percha Corporation excepts Brazil from the scope of its operations, the G. P. Brazil Syndicate, Limited, having been registered in London on April 1st, with £5,000 capital, to acquire and develop the rights of Sérullas, so far as they relate to Brazil, in the process for extracting gums from the leaves of trees. The intention is to apply the method to India-rubber. But while all the terrestrial rights under these patents have been monopolised, no doubt the vendors would entertain negotiations for rights to develop the patents on all the seas, in the milky way, and on the next comet that may be headed toward this planet. These might afford a richer field than even the forests of Borneo.

"THE COMING OF THE ELECTRIC HORSE."

Lecture by Prof. S. P. Thompson.

This was the subject of an address delivered on Thursday evening in the Agricultural Hall, Wolverhampton, by Prof. Silvanus P. Thompson, D.Sc., F.R.S., Principal of the City Guilds Technical College, Finsbury, and who is this year president of the Wolverhampton Literary and Scientific Society. The address was exceedingly interesting. Prof. Thompson pointed out that we are reaching the limit of the capacity of steam power, and therefore we must look around for something superior, and that he affirms is electricity. We are, in fact, entering upon a revolution quite as momentous as that of the supercession of animal power by steam power. Electricity has served us in telegraphy for about 50 years, and in lighting for about 20 years, but its use in heavy motive power is just beginning. As far back as the time of the wedding of the Prince of Wales, London Bridge was illuminated by arc lamps, but it was at enormous cost, the energy being derived from Grove's batteries, now we use dynamos. The latter became possible as early as 1831, when Faraday discovered the mechanical mode of generating electricity, by the motion of a magnet within or around a coil of wire, but it was not till 1878 that this motion was supplied by the steam engine. Then it was that electricity began to be available for use on a large scale of lighting, and for heavy mechanical work. The first electric lighting station put up in London was at Paddington Railway Station, and the dynamos there constructed, are still at work. Since then, however, the capabilities of electric lighting plant has enormously extended, and in one generating station, 30,000 horse-power is constantly employed. Many of the larger dynamos consisted of a pulley, girt with wire coils, and rotating within a circular frame, fitted with magnets. Electric motors of 50 H.P. had an efficiency of 92 per cent., with only 8 per cent. of waste, and motors of over 200 H.P. had an efficiency of 97 per cent. In the case of steam power unaided by electrical transmission, the efficiency was much lower. In one notable instance of eight engines of 40 horse-power average, the loss of energy in transmission through belting and shafting was 43 per cent., or nearly one-half. The works of the Electrical Construction Corporation, Wolverhampton, were the first in England to be fitted with electrical motors. The principle was being extensively applied to machine tools, and thousands of pounds were saved annually in consequence. A firm in Chester applied electricity to the cranes used for the carrying of steam billets, and in this case not only were the cranes moved by electricity, but the billets were raised by electro-magnets in place of the customary attachments of chains. Here a great saving of time, labour and fuel was accomplished. Mr. T. Parker, of Wolverhampton, had provided electrical plant for colliery purposes. Electrical motors, no larger than a lady's muff, could work at 2 H.P., and no energy was wasted while work was not being done. Messrs. Siemens, of London, had saved 3,000 tons of coal a year by the substitution of electrical wires and motors for belting and shafting; and much labour had been saved in addition. Some years ago he (Prof. Thompson) suggested that a motor house should be established at Soho, or Clerkenwell, London, for the benefit of the large number of small manufacturers there who required only a little power, and that not constantly. At present each one has to meet the cost of maintaining his own steam engine or gas engine; but under the plan suggested each would have a small electrical motor, connected with the generating station by wires. He would then take only as much energy as he actually required, and there would be no waste.

In concluding, Prof. Thompson spoke of the advance of electrical traction in the United States and the Colonies. The use of horse-power on the world's tramways had greatly declined between 1890 and 1897, the mileage being reduced from 5,000 to 900, while the mileage of electric tramways had increased from 1,262 to 13,000. The province of Ontario had 900 miles of electric tramways—more than in the whole of Europe. In New Jersey one could travel 40 miles at a stretch by electric trams. In many American cities the workers were now able to reside in the suburbs, slum dwellings had declined, and the health, comfort, and morals of the people had improved. Electrical energy was being transmitted from the Falls of Niagara to the neighbouring manufacturing towns, to the great benefit of those towns; and Rome was now lit by electricity, the energy being conveyed from the Tivoli Falls. He looked forward to the time when electricity would warm our houses and be the chief motive power.

Prof. Thompson, subsequent to the lecture, was present at a supper in his honour given by the members of the society, and in reply to the toast of his health, the President said that we in this country were several years behind America in respect to electric lighting, but we benefited by being behind. The Americans had been too anxious to make use of their inventions, and had spent money like water on miniature schemes. We had started later, and had had full benefit of later experiment and research. In America many of the earlier enterprises were not paying, while in England nearly all our electrical companies were in a sound financial condition, and paying a good, and in some cases, a splendid dividend. Electric lighting companies were, indeed, among the best forms of investment. Mr. Chamberlain was responsible for an Act of Parliament which had retarded enterprise of this character; but this retardment had been most profitable, for it had prevented great waste of money in wild-cat speculation in the execution of miniature schemes, and in the laying down of large quantities of imperfectly designed plant. We had waited and had begun on a sound and substantial basis. In Boston, U.S.A., three sets of machinery of electric lighting had been successively laid down, showing that it was possible to pay too dearly for progress.

THE SENTINEL CIRCUIT-BREAKERS.

The automatic circuit-breakers which are being introduced by the Sentinel Electric Company, of Wilmington, Del., depend for their action upon a principle which is claimed to be not only novel, but extremely effective and reliable.

The actual disruption of the circuit is accomplished by the destruction of a brittle metal bar which is included in the circuit, and which is provided with grooves to localise and insure the break.

The illustrations herewith show the single pole style of a type which, in its several sizes, is designed to protect electric light services of from 6 to 200 amperes at any voltage up to 250, and which is said to be adapted to alternating and direct current circuits with an equal degree of efficiency.

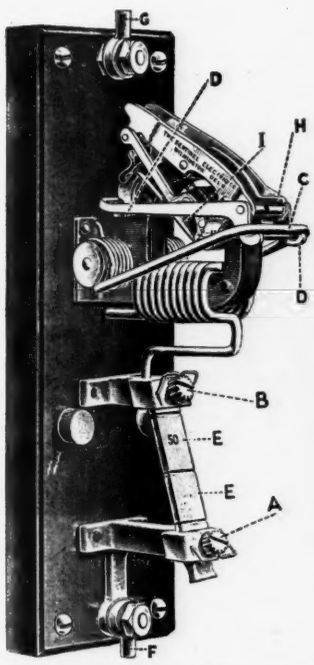


Fig. 1.—Sentinel Circuit-Breaker Set.

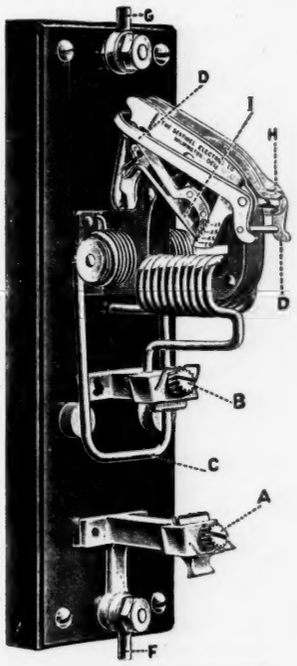


Fig. 2.—Sentinel Circuit-Breaker Discharged.

Referring to the accompanying illustrations, the breaking bar E E, fig. 1, is, upon the discharge of the circuit-breaker, struck and broken by the hammer spring C, as shown in fig. 2. When setting the device, with the upper mechanism D D, as shown in fig. 2, the operator raises the spring C, until it encounters and lifts the trigger H, when the lever D D will fall and leave the hammer spring set. A new breaking bar E E is then inserted after the stubs of the old bar have been removed.

Some of the advantages and important features which are claimed and guaranteed for this device are: (1) An annual inspection is all that the circuit-breakers require. (2) A perfect electrical connection is insured each time the device is recharged by the necessary insertion of the new bar. (3) Owing to their low ohmic resistance and the fact that they introduce no appreciable "lag" on alternating current, fuses may be replaced with no appreciable increase in the total losses. (4) The mechanical design of the device is such that vibrations do not affect it in any way, and once "set" it will remain so indefinitely unless the discharging point is purposely altered.

When the circuit-breakers are employed to protect light services, it is claimed that they perform successfully the functions of both a switch and circuit-breaker, as the circuit may, in all cases, be closed by the insertion of a new bar and opened either by removing the bar or by discharging the hammer spring by hand, thereby destroying it. This feature is especially valuable in the case of a serious short circuit or ground on the service wiring. According to present practice, the operator upon finding a protective device "blown" is required to open the switch controlling the service; he then recharges the device and closes the circuit by closing the service switch. Under similar circumstances the Sentinel circuit-breakers merely require that the spring C be set, the old bar stubs removed by loosening the screws A and B, and a new bar M E inserted. If the abnormal load is still "on" the bar will be broken by the hammer spring the instant the former touches the upper bar holder, and such an action is accomplished without danger of injury to the operator.

A combined switch and circuit-breaker also involving the breakable-strip principle, but adapted especially to the protection of motors, has been perfected by this company, and performs in a novel and efficient manner the functions of both devices.

MOTOR-DRIVEN PRINTING PRESSES.*

As was to have been expected, printers have not been the last to avail themselves of the advantages which recent discoveries by the students of electric science have placed at the disposition of industrial enterprise.

The advantage is obvious of a system which renders it possible to locate presses and other printing machinery in any part of an establishment, exclusive of line shafting, and also to run any one press at any time independent of the others. With presses equipped with direct-connected motors, each can be run at any hour of the day or night, with an expense of power proportionate to the work done, instead of that requisite for running a boiler, engine and heavy friction load of shafting and belting.

What such a saving amounts to may be judged by an estimate made by Prof. Benjamin, of the Case School of Applied Science, of Cleveland, Ohio. In 16 establishments whose plants Prof. Benjamin tested, there was developed 1,808 horse-power, and of this 979 horse-power, or 51 per cent., was expended in driving the shafts, pulleys and countershafts, while all the machines were idle. There are cases on record in which the loss of power in transmission from engines to machines, through belts, is much higher even than this, ranging from 80 to 93 per cent. of the total power generated.

So direct an appeal to economy as is made by such facts as these has a strong tendency to increase the already rapid process of installation of electric power plants.

Another great advantage of direct-connected motor to the press or other machine is that an accident to the power does not affect the whole plant, as the breaking of a belt or the main shaft causes a complete shut-down until repaired. And this by no means infrequent occurrence very often assumes the proportions of a real catastrophe.

NEW PATENTS.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*]

3,645. "Arrangement for transmitting telegraphic messages in contrary directions simultaneously over a single wire." M. Bernstein, proprietor of the firm of J. F. Wallman & Co. Dated February 14th. (*Complete.*)

3,695. "Improvements in magnetic circuits or parts of circuits.' E. Wilson. Dated February 14th.

3,731. "Transmitting drawings, pictures, sketches, and the like by telegraph or telephone." J. M. Martin. Dated February 15th.

3,749. "A method of oxidation and bleaching by means of electrolysis." J. G. A. Rhodin. Dated February 15th.

3,783. "A new or improved method of and apparatus for generating electricity." C. O. Barrows and C. H. Smith. Dated February 15th.

3,796. "Improved means for displacing, dispersing, or extinguishing arcs formed in breaking electrical circuits." S. H. Short. Dated February 15th. (*Complete.*)

3,805. "Improvements in electrical switch apparatus." T. H. Minshall. Dated February 15th.

3,806. "Improvements in apparatus for making and breaking electric circuits at predetermined times." H. O. Swoboda. Dated February 15th.

3,808. "Improvements in impedance coils for enclosed arc lamps." G. Thomas-Davies. Dated February 15th.

3,827. "Improvements in blocks and electros and surfaces for printing from." G. T. Teasdale-Buckell. Dated February 16th.

3,838. "Improvements in electric accumulators." A. Webb. Dated February 16th.

3,841. "Improvements in the method of and means employed for connecting electric glow lamps to main conductors." F. Palm. Dated February 16th. (*Complete*)

3,850. "Improvements in holders for electric glow lamps." W. Giepel, F. M. T. Lange and W. R. Saltrick. Dated February 16th.

3,902. "Improvements in devices for protecting electric incandescent lamps from the action of moisture." H. Beau and M. Bertrand-Taillet. Dated February 16th.

3,905. "Improvements in suspension devices for electric and other lamps." P. G. Pasquet. Dated February 16th.

3,924. "Improved fastening for the heads of electric glow lamps." J. Kremenezky. Dated February 16th.

3,925. "Improvements in electric safety fuses and lamp connections." H. C. Gover and J. M. Moffat. Dated February 16th. (*Complete.*)

3,960. "Improvements in electric switches." J. Williams and W. M. Walters. Dated February 17th.

3,993. "Improvements in, or relating to, electric ignition devices for internal combustion engines." A. J. Boult. (La Société Nouvelle des Etablissements Decauville Aine, France.) Dated February 17th. (*Complete.*)

4,002. "A new and improved telephone support and an automatic circuit controller." L. Duque. Dated February 17th.

4,004. "Improvements in switches for altering the speed and direction of revolution of electric motors, and for altering the course of the electrical current round field magnets." W. R. Edwards and S. F. Beevor. Dated February 17th.

4,046. "Improvements in, or connected with, the distribution of electricity on the three-wire system with the neutral wire at earth potential." A. B. Blackburn, W. L. Spence and E. S. W. Moore. Dated February 17th.

4,075. "Improvements in methods and apparatus for electro-thermally treating materials, more particularly for the manufacture of calcium carbide and other carbides, and the reduction of ores." H. Maxim. Dated February 18th.

4,114. "Improvements in telegraphic apparatus." F. W. Golby. (B. Fidler, Austria.) Dated February 18th.

4,121. "Improvements in telephones, telegraphs, and other forms of electrical signalling." E. Wilson and H. Godsal. Dated February 18th.

4,150. "Improvements in electrical accumulators or storage batteries." T. W. Allan and Allan & Adamson, Limited. Dated February 19th.

4,176. "Improvements in the distribution of electricity over electric railways." M. Cattori. Dated February 19th. (*Complete.*)

4,202. "Improvements relating to the displayal of words or devices by electrical illumination." W. J. H. Jones. Dated February 19th.

ELECTRICAL PATENTS OF 1884, EXPIRING IN MARCH, 1898.

We are informed by Messrs. W. P. Thompson & Co. that about 85 applications for electrical patents were filed in the month of March, 1884. Out of these some were never completed, and of those that were, only one has been allowed to run its full length of term, viz., 14 years, and being of interest we give a small abstract below:—

4,828. "Improvements in telegraph posts." J. Oppenheimer. Dated March 13th, 1884. Relates of the construction of forming telegraph posts of metal tubes of various oval sections. Thus strength and lightness are secured, and the attachments have no tendency to turn round the post.

*From the *Inland Printer* (American).